HIDDEN LAKE DAM REMOVAL AND NW INNIS ARDEN WAY CULVERT REPLACEMENT CONCEPT DESIGN

SHORELINE, WASHINGTON

Prepared for
City of Shoreline

Prepared by
Herrera Environmental Consultants, Inc.

HERRERA

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SHORELINE, WASHINGTON

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EXECUTIVE SUMMARY

This report represents the culmination of the Hidden Lake Dam Removal Phase 1 (Pre-Design) and presents design concepts for removing the Hidden Lake dam, replacing the NW Innis Arden Way culverts, and restoring Boeing Creek throughout the existing lake, dam, and culvert areas.

The Boeing Creek channel restoration concept is intended to minimize sediment deposition and flooding while providing habitat. The new creek channel will be created amid the existing lake bed and adjacent areas on the east edge of the lake. As the new channel passes through the existing dam site and NW Innis Arden Way crossing, its bed will be relatively deep below surrounding ground, requiring structural walls on both sides of the creek.

Replacement of the NW Innis Arden Way culverts is complicated by the tall roadway embankment height and utilities. Two options for culvert replacement are described in this report:

1. Completely walled excavation that minimizes excavation and utility impacts but requires a unique, custom culvert installation tied into the vertical shoring walls, or

2. Sloped excavation with minimal use of shoring walls, allowing installation of a precast concrete box culvert.

Both of these options would require a full closure and detour of NW Innis Arden Way during culvert replacement construction. These two approaches can be compared with regard to differences in costs, extents of construction easements needed, utility impacts, and total duration of road closure.

Construction of the culvert replacement, dam removal, and upstream channel restoration will likely require two years. In-water work will be confined to an anticipated time period of July 15 to September 30 each year (per Washington State permitting requirements), which is likely not enough time to complete all in-water work elements in the same year. The project could be sequenced to remove the dam and restore the "lake reach" of the creek in year 1 of construction, then remove and replace the culverts under NW Innis Arden Way in year 2 (or a later year if a longer term delay between phases is necessary), or vice versa.

Table ES-1 highlights potential construction issues that would be affected by project construction sequencing, assuming dam removal occurs in year 1 of construction regardless of whether stream restoration through the lake reach or culvert replacement beneath the road is done in that same year.

Table ES-1. Summary of Construction Issues and Associated Approaches Affected by Project Sequencing.		
Construction Issues Affected by Sequence	**Work Sequencing Approaches**	
	Culvert Reach and Dam Removal Prior to Lake Reach	**Lake Reach and Dam Removal Prior to Culvert Reach**
Temporary streamflow bypass system	Can use lake to impound excess flows, with potential bypass savings	Need to have higher bypass capacity for higher peak flows
NW Innis Arden Way culvert inlet trash rack(s)	No need to install new trash rack(s) on culvert inlet	Need to install new trash rack(s) on existing culvert inlets
Steep slope stabilization in dam area	Higher efficiency in that retaining walls can be extension of culvert walls	Need to install temporary slope stabilization that is partly or completely replaced as part of new culvert installation
Creating coincident streambed elevation on upstream side of the road	Some additional grading required in year 2 of construction to connect the new streambed through the culvert with the streambed in the vicinity of the existing dam	Additional excavation and streambed lowering needed in year 2 of construction to achieve finished bed elevation that is lower than concrete pad at existing culvert entrance
Disposal of excavation spoils	To minimize earthwork costs, need to stockpile approximately 2,100 cubic yards until lake reach construction occurs	Can be placed directly into the lake bed as backfill

To minimize project uncertainties, the City has requested that the Hidden Lake dam removal and NW Innis Arden Way culvert replacement conceptual design elements be located within the City's Shoreview Park property and the NW Innis Arden Way public right-of-way to the maximum extent possible. However, it is not possible to complete the project without some construction work on private properties. The City has yet to obtain permission of multiple private property owners; this will be an important part of the pending design and construction phases of the project.

Preliminary cost estimates for construction, design, permitting, and postconstruction vegetation management to satisfy anticipated permit requirements for each of the lake and culvert reaches of the project are summarized in Table ES-2. The cost estimates were prepared in 2017 dollars with two years of construction in mind (though not necessarily in successive years). Final project design work should focus on optimizing the sequencing to minimize project costs and duration of road closures.

Table ES-2. Summary of Preliminary Cost Estimates for Final Design, Permitting and Construction.	
Project Components	**Estimated Total Cost in 2017 Dollars**
Remove dam	$200,000 to $225,000
Restore creek channel through existing lake area	$1,215,000 to $1,270,000
Remove and replace culverts beneath NW Innis Arden Way – Option A: vertical shoring walls with cast-in-place culvert	$2,460,000
Remove and replace culverts beneath NW Innis Arden Way – Option B: sloped excavation with precast box culvert	$2,090,000

INTRODUCTION

This report presents the preferred conceptual design for Hidden Lake dam removal, Boeing Creek culvert replacement under NW Innis Arden Way, and Boeing Creek realignment and habitat restoration from upstream of the lake to downstream of the road. This report focuses specifically on project components and associated costs, considerations for construction phasing, geotechnical findings affecting design, and other important considerations for detailed design development.

Existing Conditions Affecting Project Design and Construction

The Hidden Lake Dam Removal Project is being undertaken by the City of Shoreline (City) in response to a City Council decision to cease sediment dredging operations in the lake. Ongoing sediment deposition will eventually fill the lake, at which point the existing dam spillway and outlet works cannot be counted upon to safely pass flows during storm events. The City plans to remove all or part of the dam impounding Hidden Lake, creating a free-flowing stream through the existing lake area.

Several site characteristics constrain the design described herein. These include adjacent private properties, a relatively significant elevation drop through the project area, steep slopes above the creek and lake, accessibility for construction, shallow groundwater in the dam and road crossing area, and completing all of the project work amid an actively flowing stream that does not dry out in the summer months when the construction work would be permitted to occur. The conceptual design seeks to emulate functioning Boeing Creek habitat that can be found upstream of the lake and in the lower reach of Boeing Creek as it approaches the Puget Sound shoreline. In those areas, the stream gradient is on the order of 2 percent. Thus, the design seeks to maximize segments of new and modified stream channel with an approximately 2 percent gradient.

Boeing Creek flows beneath NW Innis Arden Way in two parallel culverts that are estimated to be approximately 60 years old, and nearing the end of their functional life. The City is interested in replacing those culverts with a wider, fish-passable culvert that can also reliably pass wood debris and sediment so that after the dam is removed there is minimal need for maintenance attention in this area of Boeing Creek for decades to come. The earth fill embankment that the road is built upon is deep; the road surface is 30 to 35 feet higher than the existing streambed and culvert invert elevations. There are existing sanitary sewer, water, gas, and cable utility lines buried in the road right-of-way that will need to either be rerouted around the construction area (if feasible) or be supported and protected to ensure continuous operation during and after excavation for culvert removal and replacement.

The project site is at the west edge of Shoreview Park, which is a heavily used public park with trails that extend toward the existing lake through forested areas. Restoring a free-flowing stream through the lake represents a great opportunity to educate the public about ecological restoration and to improve deficiencies in the existing trail network.

Sequencing, phasing, and timing for Hidden Lake dam removal and NW Innis Arden Way culvert replacement work elements are to be determined. Dam removal is tentatively scheduled for 2020 (with $1,600,000 in construction budget allocated in the City's Capital Improvement Program (CIP)), as driven by the motivation to minimize flood risks related to ongoing sediment in-filling of the lake. Sedimentation is largely driven by major storm events and slope failures upstream within the park ravine. The City has seen in the past that one or two major storms in the wet season can cause a large amount of sediment deposition in the lake that greatly reduces

its capacity to store water and sediment. Because the timeframe for lake in-filling is difficult to predict, the City intends to remove the dam and restore a free-flowing stream through the existing lake area comfortably ahead of a point in time when it could otherwise be forced to react in a hurry.

While replacement of the creek culverts beneath NW Innis Arden Way will also reduce flood risks, the need for culvert replacement is largely driven by the condition of the existing culverts. A CCTV inspection of the main (lower elevation) 48-inch-diameter concrete culvert in April 2012 revealed some signs for concern—minor cracking and two small holes—but the overall condition of the culvert appears to be sufficient to remain in place for several more years without significant risk of catastrophic failure. While it would be most efficient to replace the two culverts at the same time as Hidden Lake dam removal, funding limitations may push culvert replacement to a later date. A $300,000 flood reduction grant awarded by the King County Flood Control District will allow the City to develop the NW Innis Arden Way culvert replacement design in combination with the Hidden Lake dam removal design, which will yield better integration of all project elements to achieve the City's objectives and a better understanding of construction approaches and costs for a combined project. However, construction funding for NW Innis Arden Way culvert replacement is not currently allocated in the City's CIP, meaning that additional funding will need to be secured to allow for implementing a combined project or else construction of the culvert replacement components will be phased to occur a year or more later.

This report addresses several issues related to uncertainty in construction sequencing, but generally assumes that the Hidden Lake dam removal and NW Innis Arden Way culvert replacement work elements will be implemented in some kind of combined project effort.

Recommended Design Configuration

The following sections elaborate on the specific project components of the design, including the rationale for using a particular design approach, materials of construction, and design issues to resolve as the project proceeds. The specific design components are creek channel realignment and restoration, dam removal, culvert replacement, and trail realignment. The recommended design configuration was driven by the following factors:

- Minimizing construction elements involving private properties
- Reducing potential for City park users to trespass onto private properties
- Prevailing geological conditions including steep slopes above the lake and creek and soil and groundwater conditions in the dam and road crossing areas
- Potential for future fish passage (an expanded discussion is provided below)
- A desire to replicate and use natural, pre-Hidden Lake historical landscape features
- Avoiding removal of significant trees

Boeing Creek Channel Realignment and Restoration

The design of a restored stream channel through the existing Hidden Lake area is presented in the drawings in Appendix A and includes the following elements:

- Create an engineered, fish-passable channel that is stable during high flows, with an alignment coinciding with what appears to be the pre-Hidden Lake historical alignment of Boeing Creek near the eastern edge of the lake.
- The designed channel width (12 feet at bankfull depth) is based on observed channel conditions in the lower reach of the creek near its mouth.
- Provide sufficient channel gradient and associated hydraulic characteristics in a range of flow conditions to encourage sediment transport, thereby preventing sediment aggradation problems in the project area while also expanding the Boeing Creek delta in Puget Sound, which will improve habitat for Chinook salmon and other aquatic species.
- Emulate channel characteristics that exist near the mouth of Boeing Creek between the railroad crossing and the existing Seattle Golf Club diversion dam.
- Include wood along the new channel banks for aquatic habitat enhancement as well as bank toe scour protection.
- Sections of the new channel with 3 percent gradient have a thicker layer of imported streambed material (cobbles, boulders, gravel, and sand) to act as "streambed

stabilization bands." If the channel bed scours or otherwise deforms in a 2 percent gradient section, any potential downcutting that could compromise a significant length of the channel for fish passage will be contained between 3 percent gradient sections because those 3 percent sections should resist scour and deformation.

- The channel centerline is set back from the toe of the slope on the park (east) side to the maximum extent feasible without requiring removal of several large trees or encroaching on private property, while still being aligned with the apparent historical channel alignment. This alignment provides a buffer between the channel and the toe of the slope, to ensure that restoring the creek channel in that location does not lead to unwanted slope erosion.

- Stream channel banks will not be armored and thus will allow natural channel migration. While significant channel migration is not expected due to the relatively high gradients throughout the site, some migration can occur. If a tree falls in the channel and blocks the flow path, the stream will have space to meander without compromising its intended functions.

- A woody revetment fronting backfill between Stations 9+50 and 10+75 (see design drawings in Appendix A) will block off the current stream channel alignment at the upstream end of the project area, ensuring that the creek flow stays in the new channel alignment during high flows.

- A woody revetment between Stations 3+75 and 4+50 is included in the design to prevent channel migration onto private property.

- Rock/coir wrap embankment toe protection on the left (east) bank of the new channel between Stations 9+50 and 10+75 will prevent destabilization of the slope to the east.

- A soldier pile wall at the toe of an existing near-vertical slope on the right (west) bank between Stations 2+25 and 3+25 will prevent creek flow from triggering a slope failure. This wall will transition into the right sidewall for the new NW Innis Arden Way culvert.

- A soldier pile retaining wall at the toe of the slope on the left (west) side of the creek channel is needed near the entrance to the culvert(s) (existing or new/replaced) to prevent destabilization of the steep slope close to the road. This wing wall will be similar in size and orientation to an existing concrete wing wall in that area.

- A temporary rock buttress at the toe of the steep slope on the left bank between Stations 2+25 and 3+25 will prevent creek flow from eroding and destabilizing the steep slope east of the creek approaching the new culvert wing wall until completion of the culvert reach when design grade is reached.

- A soldier pile wall at the toe of an existing near-vertical slope on the left (east) bank between Stations 3+00 and 3+40 will prevent creek flow from triggering a slope failure.

Hidden Lake Dam Removal

Removal of the dam should be relatively straightforward to accomplish, but the impounded lake water should be drained before commencing dam removal. Before the dam fill material is removed, the existing manhole structure and trash rack that serve as the primary lake outlet will need to removed. Additionally, gabion mattresses (small quarry rock contained in a metal "cage") on the downstream face of the dam will likely need to be "peeled" away before faster dam fill excavation can occur. Two parallel 30-inch-diameter corrugated polyethylene lake outlet pipes (extending approximately 75 feet from the existing lake outlet structure) buried within the dam will also need to be removed as dam fill excavation occurs.

Project construction must consider the need for construction equipment access to the stream work areas through the lake, and how to either make use of the existing dam for a period of time to serve as an access driveway into the upstream work areas around Hidden Lake, or install a separate access driveway if the dam is removed as part of culvert replacement preceding stream channel construction through the existing lake area upstream of the dam.

Culvert Removal and Replacement

Design and construction of the culvert removal and replacement elements of the project are complicated by the height of the earth fill embankment above the existing culverts. Two basic options for the approach to removing the existing culverts and replacing them with a new stream channel contained within a wider culvert structure are described in this report: 1) a completely walled excavation that minimizes the area of excavation radiating away from the culvert/stream alignment and simplifies temporary utility protection but requires a unique, custom culvert installation tied into the vertical excavation shoring walls, and 2) a sloped excavation that minimizes use of shoring walls to contain the lateral extents of the deep excavation and allows installation of a precast concrete box culvert. These two options generally "bookend" the way a construction contractor could conduct the work with varying extents of ground disturbance. Both options would require complete closure of NW Innis Arden Way during excavation, culvert installation, backfilling, and roadway restoration. There are tradeoffs to these approaches, including costs, extents of construction easements needed on adjacent private properties south of the road, extents of utility modifications, and total duration of road closure.

The geotechnical analysis memorandum in Appendix B presents information that was used to create the design layouts of these two design options. The width of the new culvert (16 feet) under either design option for its installation is based on the channel width to be created through the lake area with an additional 2 feet on each side to accommodate placement of boulders against the culvert side walls.

Culvert Design Option A: Vertical Shoring Walls with Cast-In-Place Culvert

Two wall types were considered for the deepest part of the excavation beneath the road, each of which could serve as temporary shoring walls and then be left in place to serve as permanent culvert side walls: secant pile walls and soldier pile walls. Secant pile walls would enable one lane of traffic to be maintained on the road for a portion of the construction duration, whereas soldier pile walls would require complete road closure but would be less expensive. Based on feedback from the City that closure of NW Innis Arden Way is likely acceptable for a longer period of time (minimum 2 months), soldier pile walls were selected.

The lower part of each soldier pile shoring wall (on each side of the restored stream channel) could serve as a permanent culvert wall via using concrete or other durable material fascia panels. A precast or cast-in-place concrete lid, resting on support beams parallel to the channel on each side wall (walers), could form the top of the culvert and support soil backfill above the culvert to road level. With this construction method, the soldier pile walls used for shoring the deep excavation can be left in place permanently. Bracing would be needed between the walls within the excavation because it would not be feasible to install tie backs in the lower part of the wall height given the narrow width of the excavation. Therefore, bracing would be needed between the soldier pile walls to prevent the walls from leaning inward during culvert removal and replacement. It is assumed that an excavator at road level could excavate soil between the shoring walls to approximately mid-depth of the excavation beneath the road; and, thereafter, a contractor would use a bulldozer or other lower-profile equipment to come in from either upstream or downstream to complete the lower part of the excavation (from upstream is likely more feasible given the City's existing easement on the north side of the road can be used for access), and that the equipment would need to fit vertically amid the bracing. Therefore, the lower part of the excavation would likely progress slower (and at greater cost) than the upper part of the excavation. The excavation would also require removing an existing sanitary sewer manhole on the south side of the road, and likely replacing it with a manhole farther away from the new culvert alignment. During the excavation, the existing culverts could be used to pass streamflow through the work area until it is time to remove them and install the new culvert and streambed material within it. Once the existing culverts are removed, the contractor would need to install another flow conveyance/bypass system while completion of streambed excavation, culvert sidewall installation, and streambed material placement occurs.

Available subsurface information (see Appendix B) indicates that there is a glaciolacustrine soil contact sloping down from east to west beneath the road. Borings completed in fall 2017 in the road embankment indicated that groundwater is perched atop this layer; therefore, a seepage face would be encountered as the eastern soldier pile wall is installed. The conceptual design of this option includes a seepage cutoff drain abutting the back side of the eastern soldier pile wall to intercept groundwater and direct it to the upstream and/or downstream sides of the road embankment.

Culvert Design Option B: Sloped Excavation with Precast Box Culvert

As stated previously, this design approach would enable use of a precast concrete box culvert structure (either 3-sided/bottomless on strip footings or 4-sided without need for foundation footings) but would entail a much larger excavation footprint prior to culvert installation. The excavation would require removing an existing sanitary sewer manhole on the south side of the road, and likely replacing it with a manhole farther away from the new culvert alignment, and temporary support for the existing sewer line for a considerable length across the width of the excavation parallel to the road. It is assumed that the water line could either be supported across the wide excavation similar to the sewer line (i.e., a temporary utility bridge), or water service could be shut off and the line partially removed until replaced at the conclusion of backfill placement above the new culvert. It is further assumed that the franchised gas and cable utilities beneath the road could be rerouted around the work area until the conclusion of backfilling.

The geotechnical analysis memorandum in Appendix B presents details on soil characteristics as related to shoring needs, groundwater that would be encountered during excavation, and the angle of repose that can be assumed for sloped excavation.

Construction equipment would need to access the lower part of the excavation. This requires a sloped bench on one or both sides of the excavation. A preliminary assessment of dump truck turning radii indicates that it would be feasible to use the following procedure to remove excavated soil and deliver culvert materials: trucks arrive at the site from NW Innis Arden Way to the west (i.e., via 10th Avenue NW and NW 175th Street), back up into a temporary access driveway extending through the City's easement on the north side of the road (west of the creek), curl around southward into the benched access driveway through the excavation, and load and unload materials before driving out (forward) the way they entered. The proposed site plan in Appendix A shows this construction access route. While this could be a feasible way to complete the excavation and install the new culvert and associated wing walls, it would be relatively slow going, adding to a contractor's costs.

During the excavation, the existing culverts could be used to pass streamflow through the work area. If the bottom of the excavation were 4 feet wider than needed to install the new culvert, one of the existing culverts could be used for a longer period of time to route streamflow through the work area, expediting culvert installation. Widening the bottom of the excavation for this purpose could also be done with Option A, but for either option it would add to the cost.

Streambed Within Culvert

Making the stream profile through the culvert crossing fish-passable is challenging due to the incised channel characteristics downstream of the road. Downstream incision increases the overall elevation drop from upstream of the existing Hidden Lake dam area. A "roughened channel" configuration per Washington Department of Fish and Wildlife (2013) guidelines, which

is a means of transitioning grade through a relatively steep section of channel, is included in the design to minimize the length of channel modifications downstream of the road crossing. The result will be a relatively steep section of channel (10 percent gradient) at the downstream end of the project extent.

In July 2017, the project team completed a memorandum for Concept Design Evaluation of Fish Passage Improvements in Lower Boeing Creek, for a roughly 1,100-foot-long reach of Boeing Creek from NW Innis Arden Way to downstream of the Seattle Golf Club diversion dam (Herrera 2017). Results of this analysis indicated that successful implementation of lower Boeing Creek fish passage improvements would be very difficult as a City-led project, with high costs, substantial risks, and many uncertainties. City staff concluded (with Council concurrence) that such an approach would not be viable for restoring fish passage to the reach of Boeing Creek upstream of Hidden Lake, nor for securing fish passage-oriented grant funding for the Hidden Lake Dam Removal Project. Accordingly, the City has discontinued further development of Boeing Creek restoration concepts downstream of NW Innis Arden Way.

Results of that downstream fish passage analysis were referenced in creating the current NW Innis Arden Way culvert replacement design concept. The conceptual channel bed profile extending through the NW Innis Arden Way crossing in that downstream fish passage analysis (Herrera 2017) was several feet lower than the concept design currently reaches. This is because of the high cost and constructability concerns for deeper streambed elevations from the dam area to downstream of the road. The elevation of the downstream tie-in to the existing creek channel is approximately 172 feet (near Station 1+00 on Drawing C-2 in Appendix A), which is roughly 7 vertical feet higher than the elevation proposed by the "ideal" downstream fish passage restoration concept developed for lower Boeing Creek. Therefore, any potential future attempts to implement fish passage improvements in lower Boeing Creek would need to accommodate greater elevation drop between the outlet of a new culvert beneath NW Innis Arden Way and the mouth of the creek at Puget Sound. Doing so is feasible, but adds to the challenges and very high costs. It should be noted that the conceptual stream channel profile through the road crossing presented in the drawings in Appendix A is consistent with geotechnical engineering findings and recommendations presented in Appendix B, which infer the predevelopment historical channel elevation of Boeing Creek at the roadway crossing.

The Lower Boeing Creek fish passage improvement concepts developed by the City in 2017 could still be implemented as conceived to extend the length of fish passable channel by up to an additional 1,000 feet, including removal of the Seattle Golf Club diversion dam and rock cascade obstructions. Those potential improvements would not be impacted by the higher outlet elevation of the NW Innis Arden Way culvert; however, attempting to extend such downstream fish passage improvements through the NW Innis Arden Way culvert would encounter a short section of channel downstream of the road with a grade that is probably too steep for fish passage, requiring some form of an engineered fishway to enable passage through that section.

Hidden Lake Loop Trail Realignment

The Hidden Lake Loop Trail runs through the northern part of the project area along the northeastern shore of Hidden Lake. The conceptual design of the project includes reconfiguring approximately 300 linear feet of the Hidden Lake Loop Trail alignment through the project area. The proposed trail realignment would shift the trail away from the existing lake shore about 80 feet eastward and 10 to 20 vertical feet up the existing slope. With the lake removed, existing lake access points will no longer be needed. Shifting the trail to the east will keep trail users close to but upslope of the new Boeing Creek alignment, discourage trespassing onto private property on the opposite (west) side of the creek, and eliminate the need for (and cost of) two new trail bridges over the restored creek channel within the project limits. The trail realignment also proposes constructing a small platform at the south end of the new trail section for viewing (from above) the restored stream channel. The viewing area will include educational signage to illustrate Hidden Lake history, stream restoration concepts, and/or other surface water and environmental topics. The trail realignment could also propose installing a small spur trail lower down on the east side of the new Boeing Creek alignment to allow for guided exploration of the newly restored channel.

CONSTRUCTION SEQUENCING

The project design presented in the drawings in Appendix A is likely complex enough to require two years of construction (with in-water work being confined to an anticipated time period of July 15 to September 30 each year per Washington State permitting requirements). This is because the deep excavation beneath NW Innis Arden Way will prolong the time needed for culvert work and simultaneous road closure, making it challenging for a contractor to also be working on the creek channel restoration through the lake area within the same timeframe. The project could be sequenced to remove the dam and restore the "lake reach" of the creek in year 1 of construction, then remove and replace the culverts under NW Innis Arden Way in year 2 (or a later year if a longer term delay between phases is necessary), or vice versa. To minimize repeat construction work in the vicinity of the dam site in year 2 of construction, the dam should be removed in year 1 regardless of whether the lake reach or culvert reach is constructed first.

If the dam is removed in combination with constructing the culvert reach in year 1, Boeing Creek would flow across the former lake bed in a somewhat unpredictable manner until the stream restoration work is constructed in the lake reach in an ensuing year. This scenario would not likely undermine or damage project features constructed at the former dam site and through the improved road crossing, but would be expected to result in unpredictable lake bed topography that a construction contractor would encounter in mobilizing to complete the lake reach work. That unpredictability could induce some added costs to complete the project.

If the culvert replacement work is done first, the dam and lake could possibly be used to impound any "excess" Boeing Creek flow for a period of weeks when the lower-elevation culvert removal and installation work is occurring, which could expedite the contractor's time to complete culvert installation. However, Boeing Creek base flows would need to be allowed to continually pass through to protect aquatic life in the creek downstream of the project area. This approach to controlling creek flows during construction would involve draining the lake (to maximize whatever capacity of water storage remains at that time as related to ongoing sediment accumulation in the lake) and then blocking the existing outlet structure and bypassing a suitable base flow rate to the downstream end of the culvert replacement work area. Saving time for culvert removal and replacement could reduce construction costs and could reduce the duration of road closure for the neighborhood. However, if the dam is removed in the first year of construction as suggested above, it will be necessary to install a full-capacity temporary flow-bypass system through the excavation beneath the road during ensuing culvert removal and replacement. That type of temporary diversion system is common for construction work in creek and river channels.

With dam removal (along with the manhole and pipes that are used to route lake outflows through it) as part of creek restoration work through the lake area in year 1 of construction, a durable trash rack would be needed to protect the upstream entrance to the existing NW Innis Arden Way culverts until they are replaced. This could be a cost and maintenance issue for the City.

Another issue related to the timing of dam removal is stabilizing the toes of the steep slopes on both sides of the creek between the dam and the upstream entrance to the culvert(s) (for both existing and proposed culverts, that entrance is in the same location). With dam removal in the first year of construction, temporary or permanent stabilization measures for the toe of slopes on each side of the new creek channel would be necessary. As currently designed, it would probably be more efficient to construct those features in combination with culvert replacement (for example, the soldier pile wall at the toe of slope on the west side of the lowered stream channel through the dam site is intended to be an extension of the same type of wall built beneath the road under Option A, but the same type of soldier pile wall to protect the right bank could be installed under Option B). The new creek bed in the area just upstream of the road crossing will be slightly lower in elevation than the existing concrete pad that routes flows into the existing culverts; thus, installing permanent slope toe stabilization measures cannot be accomplished completely while the concrete pad remains in place.

Table 1 highlights potential construction issues that would be affected by project construction sequencing, assuming dam removal occurs in year 1 of construction regardless of whether stream restoration through the lake reach or culvert replacement beneath the road is done in that same year.

Table 1. Summary of Construction Issues and Associated Approaches Affected by Project Sequencing.

Construction Issues Affected by Sequence	Work Sequencing Approaches	
	Culvert Reach and Dam Removal Prior to Lake Reach	**Lake Reach and Dam Removal Prior to Culvert Reach**
Temporary streamflow bypass system	Can use lake to impound excess flows, with potential bypass savings	Need to have higher bypass capacity for higher peak flows
NW Innis Arden Way culvert inlet trash rack(s)	No need to install new trash rack(s) on culvert inlet	Need to install new trash rack(s) on existing culvert inlets
Steep slope stabilization in dam area	Higher efficiency in that retaining walls can be extension of culvert walls	Need to install temporary slope stabilization that is partly or completely replaced as part of new culvert installation
Creating coincident streambed elevation on upstream side of the road	Some additional grading required in year 2 of construction to connect the new streambed through the culvert with the streambed in the vicinity of the existing dam	Additional excavation and streambed lowering needed in year 2 of construction to achieve finished bed elevation that is lower than concrete pad at existing culvert entrance
Disposal of excavation spoils	To minimize earthwork costs, need to stockpile approximately 2,100 cubic yards until lake reach construction occurs	Can be placed directly into the lake bed as backfill

A summary of the envisioned construction components for the lake reach and culvert reach phases of the project is provided below.

Lake Reach

1. Implement temporary traffic controls on NW Innis Arden Way to facilitate ready access for construction vehicles and equipment.

2. Install temporary erosion and sediment control (TESC) measures in downstream (south) end of work area.

3. If the dam is still in place (i.e., the lake reach construction work occurs before the culvert reach work), remove it first. Install trash rack at upstream entrance to existing culverts if the culverts have not already been removed in a previous phase of culvert reach construction. Install slope toe stabilization measures in existing dam area if not already installed in a previous phase of culvert reach construction.

4. Place bulk bags at the upstream end of the project where the creek currently enters the lake to divert flow through an existing flow bypass pipe under the lake bed (outlets to the manhole at the upstream end of the dam) and drain the lake. If the flow bypass pipe connecting to the outlet manhole is no longer in place or functional, drain the lake bed and place bulk bags to tie into the eastern berm (see Appendix A, Drawing C-1) to divert flow toward the upstream entrance to the culvert(s) beneath the road (existing or new/replaced), and install other temporary erosion and sediment control features in the lake area.

5. Clear vegetation as needed (within allowed limits of disturbance) and excavate the new creek channel progressing from the existing dam area in the upstream direction.

6. Place and grade excavation spoils on the former lake bed to the west of the new channel.

7. Install wood structures and other instream design features progressively as excavation occurs, or after all channel excavation is complete.

8. Place streambed material.

9. At upstream end of new channel, use excavated rock and soil to plug the existing channel near where it passes west under a fence, permanently blocking that channel path, if this step cannot be undertaken sooner, depending on flow bypass approach.

10. Empty bulk bags with the excavation spoils and remove other temporary streamflow control and TESC measures, cap/abandon flow bypass pipe under the lake bed if it was used, and allow all creek flow to pass through the new channel.

11. Hydroseed and/or place mulch in areas to be planted.

12. Install the permanent trail improvements. (Note: this step can be completed earlier if the contractor mobilizes to the site a few weeks before the permitted in-water work window begins.)

13. Install plantings in late fall after rainy season has commenced.

Culvert Reach

1. Close NW Innis Arden Way to traffic (for minimum 2 months).

2. Install temporary erosion and sediment control measures.

3. Excavate beneath roadway and install soldier pile walls as excavation deepens (with extents of walls depending on which option used for excavation as described previously). Support and/or remove/reroute existing utilities as they become exposed in the upper part of the excavation.

4. Install another means of bypassing or controlling creek flow as existing culverts are removed and the lowest part of the excavation is completed.

5. Install precast concrete box culvert and streambed material within it, or create culvert side walls using concrete fascia panels at the base of soldier pile shoring walls to remain permanently in the ground before placing new streambed material between the side walls.

6. If culvert installation Option A used, install a precast concrete lid (in sections creating the length of the culvert top, lowered through the shoring wall bracing and utilities bridging the open excavation) or cast-in-place concrete for the culvert lid, resting on horizontal beams attached to the side walls (which could double as walers for wall bracing before the culvert lid is installed).

7. If dam was not removed in a previous phase of construction, remove lake outlet manhole and trash rack on the upstream face of the dam, and remove the gabions from the downstream face of the dam.

8. Excavate dam, remove existing lake outlet pipes, and demolish the concrete splash pad at entrance to the existing culverts

9. Complete finished channel grading and toe-of-slope protection measures upstream and downstream of the road.

10. Remove temporary streamflow control/bypass system and allow streamflow to pass through the new channel extents.

11. Backfill the excavation beneath the road (above the new culvert lid) and behind new side walls extending upstream and downstream of the road with salvaged embankment material.

12. Re-pave disturbed road areas, and open the road to traffic.

PRIVATE PROPERTY CONSIDERATIONS

Private properties play an important role in replacing the NW Innis Arden Way culvert and removing the dam impounding Hidden Lake and restoring Boeing Creek through the Hidden Lake area. Project areas with private property considerations include the following:

- An existing 110-foot section of Boeing Creek channel at the upstream end of the lake is entirely on private property.
- Significant portions of Hidden Lake are on four private properties (and also a property owned by the King County Wastewater Treatment Division).
- Part of the dam and the only dam access (and overall Hidden Lake project area access) is on a single private property (on which the City has an easement). In this same area, portions of the existing NW Innis Arden Way culvert inlet and headwall appear to be on the same private property.
- At the downstream end of the new/replaced NW Innis Arden Way culvert, retaining walls and channel restoration are expected to extend approximately 50 feet beyond the public right-of-way onto private property (two separate landowners) on both sides of the creek.

To minimize project uncertainties, the City has requested that the Hidden Lake dam removal and NW Innis Arden Way culvert replacement conceptual design elements be located within the City's Shoreview Park property and the NW Innis Arden Way public right-of-way to the maximum extent possible. However, it is not possible to complete the project without some construction work on private properties, particularly at the upstream and downstream ends of the NW Innis Arden Way culvert, within the existing dam area, and a small area upstream of the lake. Ideally, there will be full cooperation between the City and all neighboring private property owners to allow for project access, efficient construction work, and site restoration to occur in all areas as needed, and as optimal to mitigate the construction impacts including lake removal. However, the City has yet to obtain agreements for any work on private property, and that will be an important part of the pending final design and construction phases of the project.

Assumptions related to private property access, usage, and general proximity to work that were made in developing the conceptual design described in this report include:

1. All project work north of NW Innis Arden Way, including Hidden Lake dam removal, Boeing Creek restoration within the Hidden Lake area, and the upstream end of culvert replacement will utilize the existing maintenance access gate and driveway on private property. This access is currently allowed by a permanent easement.

2. The City will obtain any and all rights-of-entry, temporary construction easements, and/or permanent easements necessary to construct and (if applicable) maintain:

    a. The upstream end of the new NW Innis Arden Way culvert, Hidden Lake dam removal, and Boeing Creek restoration within that area.

    b. The downstream end of the new NW Innis Arden Way culvert.

    c. Boeing Creek channel realignment at the upstream end of Hidden Lake.

    d. Temporary stream bypass system(s) and other temporary erosion and flow diversion features.

3. The City will use excavation spoils (as suitable) to partially fill the dewatered lake bed on Shoreview Park property. Planting restoration will be done only within City right-of-way, Shoreview Park, and portions of private properties (with landowner permission) directly disturbed by construction. For the purposes of cost estimating, planting restoration has been assumed to not extend to private property areas on the west side of the dewatered lake bed.

4. Design concepts were developed to discourage park users from trespassing on private properties in the Hidden Lake area following removal of the lake.

PRELIMINARY COST ESTIMATES

Preliminary cost estimates for construction, design, permitting, and postconstruction vegetation management to satisfy anticipated permit requirements for each of the lake and culvert reaches of the project are summarized in Table 2. Itemized cost estimate tabulations are provided in Appendix C. The cost estimates were prepared in 2017 dollars with 2 years of construction in mind (though not necessarily in successive years), but without including duplicative cost items mentioned above if the culvert work is done after the upstream work in the lake reach (e.g., new trash rack at culvert entrance, partial installation of toe-of-slope stabilization measures). Final project design work should focus on optimizing the sequencing to minimize project costs and duration of road closures. Drawing sheet C-1 in Appendix A shows the dividing line separating costs estimated to be part of the lake reach versus culvert reach, to avoid any double counting or omissions.

Table 2. Summary of Preliminary Cost Estimates for Final Design, Permitting and Construction.

Project Components	Estimated Total Cost in 2017 Dollars
Remove dam	$200,000 to $225,000
Restore creek channel through existing lake area	$1,215,000 to $1,270,000
Remove and replace culverts beneath NW Innis Arden Way – Option A: vertical shoring walls with cast-in-place culvert	$2,460,000
Remove and replace culverts beneath NW Innis Arden Way – Option B: sloped excavation with precast box culvert	$2,090,000

A higher contingency (50 percent) for the construction cost elements is included for the culvert reach due to the complexities of deep excavation and wall installation that are not yet resolved. A lesser contingency (30 percent) is included for the lake reach (including dam removal) construction elements because there should be fewer unknowns and fewer design and construction challenges for that part of the project. If both reaches of the project are included in a single, phased package of design plans with ability to construct both phases without several years of lag time in between (i.e., if the City is able to obtain funding for the culvert reach relatively soon), the permitting level of effort and associated cost should be lesser than the sum of these amounts shown in the two cost tabulations in Appendix C.

REFERENCES

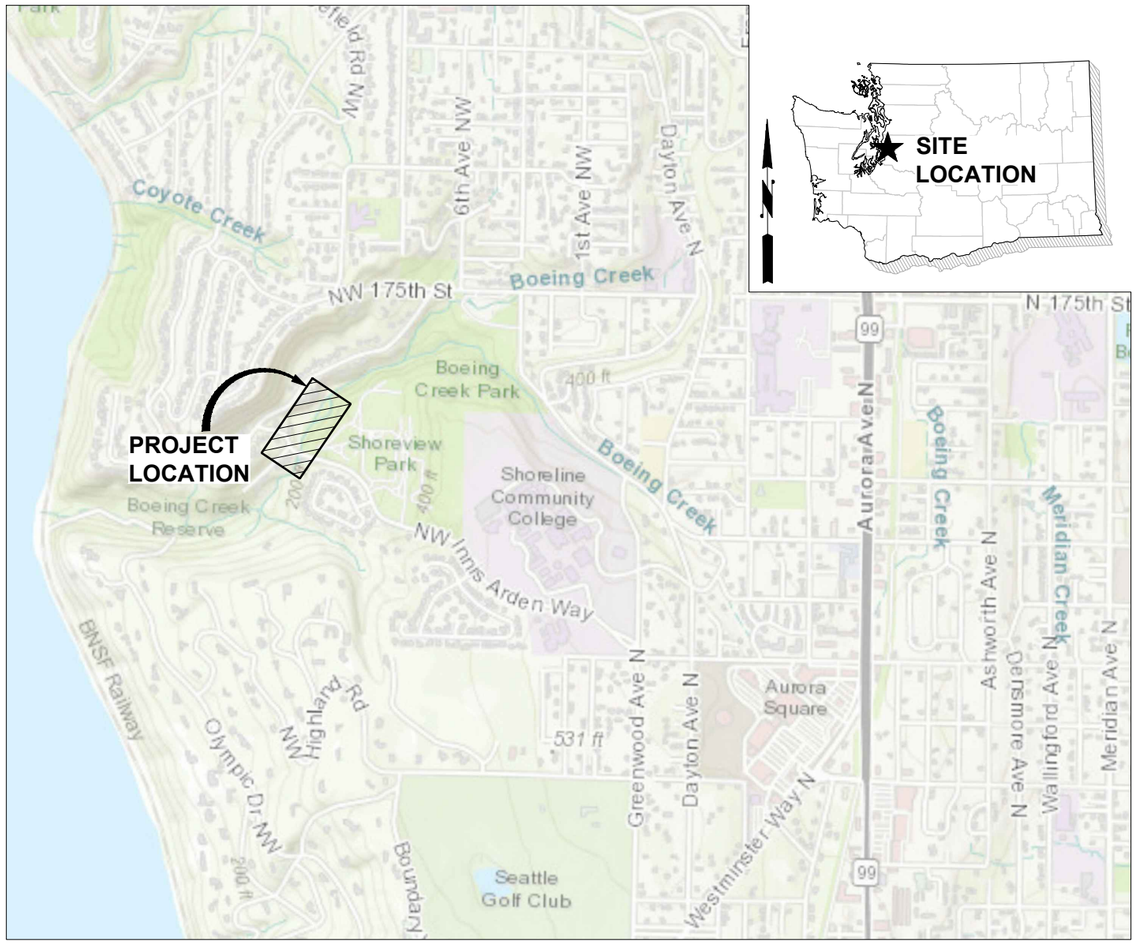
Herrera. 2017. Technical Memorandum: Concept Design Evaluation of Fish Passage Improvements in Lower Boeing Creek. Prepared for John Featherstone, City of Shoreline, by Ian Mostrenko and Mark Ewbank of Herrera Environmental Consultants, Inc., Seattle, Washington. July.

APPENDIX A

Preliminary Design Drawings

HIDDEN LAKE DAM REMOVAL

SHORELINE, WA



VICINITY MAP

SCALE: 1"=1/4 MILE

OWNER:

CITY OF SHORELINE
PUBLIC WORKS DEPARTMENT
SHORELINE CITY HALL - 2ND FLOOR
17500 MIDVALE AVENUE N.
SHORELINE, WA 98133
CONTACT: JOHN FEATHERSTONE, P.E.

ENGINEER:

HERRERA ENVIRONMENTAL CONSULTANTS
2200 SIXTH AVENUE
SUITE 1100
SEATTLE, WA 98121
PHONE: (206) 441-9080
CONTACT: IAN MOSTRENKO, P.E.

SHEET INDEX

1 / C-1 — DETAIL REFERENCE NUMBER; DRAWING ON WHICH DETAIL IS SHOWN

DETAIL (SCALE: NTS) — 1 / C-1 — DETAIL REFERENCE NUMBER; DRAWING FROM WHICH DETAIL WAS TAKEN

A / C-4 — SECTION REFERENCE LETTER; DRAWING ON WHICH SECTION IS SHOWN

SECTION/PROFILE (SCALE: NTS) — A / C-2 — SECTION/PROFILE REFERENCE LETTER; DRAWING FROM WHICH SECTION/PROFILE WAS TAKEN

"-" INDICATES THAT THE DETAIL/SECTION IS SHOWN ON THE SAME SHEET

"TYP" INDICATES THAT THE DETAIL/SECTION IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED

"VAR" SPECIFIES THAT DETAIL/SECTION WAS TAKEN FROM VARIOUS DRAWINGS

NOTE AND DETAIL/SECTION REFERENCING

ORIGINATED BY: / DATE:
CHECKED BY: / DATE:
BACK-CHECKED BY: / DATE:
CORRECTED BY: / DATE:
VERIFIED BY: / DATE:

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CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

811 Know what's below. Call before you dig.

HERRERA

IAN R. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER — DRAFT

DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL		
DESIGNED: V. WU	DRAWN: -		
DESIGNED: -	CHECKED: -		
SCALE: AS NOTED	APPROVED: M. EWBANK		

HIDDEN LAKE
DAM REMOVAL CONCEPTUAL DESIGN

COVER SHEET

DATE: JANUARY 2018
PROJECT NO: 15-05984-000
DRAWING NO: G-1
SHEET NO: 1 OF 7

GENERAL NOTES:

1. THE CONTRACTOR SHALL HAVE THE APPROVED PLANS AND ALL OTHER REQUIRED DOCUMENTS AVAILABLE AT THE JOB SITE.
2. ALL WORK SHALL CONFORM TO THESE APPROVED PLANS AND SPECIFICATIONS, THE SHORELINE MUNICIPAL CODE, THE ENGINEERING DEVELOPMENT MANUAL, 2016 WSDOT/APWA STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION, AND FEDERAL AND STATE REQUIREMENTS.
3. ALL INSTALLATION METHODS AND MATERIALS SHALL MEET THE 2016 WSDOT/APWA STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION.
4. ANY CHANGES FROM THE APPROVED PLANS REQUIRE PRE-APPROVAL FROM THE CITY ENGINEER.
5. CONSTRUCTION HOURS ARE PER SPECIAL PROVISION SECTION 1-08.0(2). APPROVED HOURS FOR LANE CLOSURES ARE IDENTIFIED IN SPECIAL PROVISION SECTION 1-10.2(2).
6. THE CONTRACTOR ASSUMES SOLE RESPONSIBILITY FOR WORKER SAFETY AND DAMAGE FROM CONSTRUCTION OPERATIONS TO STRUCTURES AND OTHER IMPROVEMENTS. ANY DAMAGE SHALL BE REPAIRED BY THE CONTRACTOR AT NO ADDITIONAL COST TO THE CITY.
7. ALL TRENCH EXCAVATION SHALL MEET OR EXCEED ALL APPLICABLE SHORING LAWS. ALL TRENCH SAFETY SYSTEMS SHALL MEET WISHA REQUIREMENTS.
8. SURVEYING FOR PUBLIC FACILITIES SHALL BE PERFORMED UNDER THE DIRECTION OF A WASHINGTON LICENSED LAND SURVEYOR. VERTICAL DATUM SHALL BE NAVD 88. HORIZONTAL DATUM SHALL BE WASHINGTON STATE (GRID) COORDINATES, NORTH ZONE, USING NAD 83/91 SURVEY CONTROL AND ANY TWO CITY OF SHORELINE HORIZONTAL CONTROL MONUMENTS. FOR PROJECTS WITHIN A FLOOD CONTROL ZONE, THE SURVEYOR SHALL PROVIDE CONVERSION CALCULATIONS TO NGVD 1929.
9. REPLACE OR RELOCATE ALL SIGNS, STRIPING, POLES AND OTHER ITEMS IN THE RIGHT-OF-WAY THAT ARE DAMAGED OR REMOVED DURING CONSTRUCTION. USE THERMOPLASTIC ON STOP BARS, CROSSWALKS, AND BICYCLE LANES. ADJUST ALL CASTINGS TO FINISHED GRADE.
10. RETAIN, REPLACE OR RESTORE ALL VEGETATION IN RIGHTS-OF-WAY, EASEMENTS, AND ACCESS TRACTS DISTURBED DURING CONSTRUCTION.
11. THE LOCATIONS SHOWN OF ALL EXISTING UTILITIES SHOWN HEREON HAVE BEEN OBTAINED FROM AVAILABLE CITY OF SHORELINE GIS DATA AND SHOULD THEREFORE BE CONSIDERED APPROXIMATE ONLY AND NOT NECESSARILY COMPLETE. IT IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR TO INDEPENDENTLY VERIFY THE ACCURACY OF ALL UTILITY LOCATIONS SHOWN, AND TO FURTHER DISCOVER AND AVOID ANY OTHER UTILITIES NOT SHOWN HEREON WHICH MAY BE AFFECTED BY THE IMPLEMENTATION OF THIS PLAN. IMMEDIATELY NOTIFY THE CITY ENGINEER IF A CONFLICT EXISTS.
12. THE EXISTING TOPOGRAPHIC AND PHYSICAL FEATURES SHOWN ON THESE PLANS ARE BASED ON THE CITY OF SHORELINE'S GIS DATA. THE CONTRACTOR MAY ENCOUNTER VARIATIONS BETWEEN ACTUAL CONDITIONS AND THOSE SHOWN IN THE PLANS. THESE VARIATIONS WILL NOT BE THE BASIS FOR A CLAIM FOR EXTRA COMPENSATION.
13. CAUTION- EXTREME HAZARD-OVERHEAD ELECTRICAL SERVICE LINES ARE NOT SHOWN ON THE PLANS. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE EXTENT OF ANY HAZARD CREATED BY OVERHEAD ELECTRICAL POWER IN ALL AREAS AND SHALL FOLLOW PROCEDURES DURING CONSTRUCTION AS REQUIRED BY LAW AND REGULATIONS. PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL MEET THE UTILITY OWNERS AND DETERMINE THE EXTENT OF HAZARD AND REMEDIAL MEASURES AND SHALL TAKE WHATEVER PRECAUTIONS MAY BE REQUIRED.
14. THE CITY ENGINEER WILL COORDINATE AND NOTIFY RESIDENTS AND BUSINESSES IN ADVANCE OF ANY WORK AFFECTING ACCESS OR SERVICE AND SHALL MINIMIZE INTERRUPTIONS TO DRIVEWAYS FOR RESIDENTS AND BUSINESSES ADJACENT TO THE PROJECT. CONTRACTOR TO NOTIFY CITY ENGINEER ONE (1) WEEK PRIOR TO COMMENCEMENT OF WORK TO PROVIDE CITY ENGINEER TIME TO NOTIFY RESIDENTS AND BUSINESSES.
15. ALL LAWN AND VEGETATED AREAS DISTURBED BY CONSTRUCTION EQUIPMENT, VEHICLES OR PERSONNEL SHALL BE RESTORED TO ORIGINAL CONDITION OR BETTER, AT THE CONTRACTOR'S EXPENSE.
16. THE CONTRACTOR SHALL PREPARE AND SUBMIT TEMPORARY STORMWATER SYSTEM BYPASS PUMPING PLAN. SEE SPECIFICATIONS FOR DETAILS.
17. THE CONTRACTOR SHALL PREPARE UTILITY PROTECTION PLANS ON AN AS-NEEDED BASIS, INCLUDING BUT NOT EXPRESSLY LIMITED TO PROTECTION PLANS FOR WATER MAINS AND SERVICES WITHIN 5 HORIZONTAL FEET OF TRENCH EXTENT SHOWN ON PLAN SHEETS.
18. PROTECT EXISTING CURB, GUTTER, SIDEWALK, DRIVEWAYS, AND SHOULDER (PAVED OR GRAVEL) TO REMAIN FROM DAMAGE. DEMOLISH ONLY THOSE EXISTING FACILITIES INDICATED ON THE PLANS. CONTRACTOR SHALL REPLACE AT THEIR COST ANY FACILITY TO REMAIN THAT IS DAMAGED AS A RESULT OF CONTRACTORS OPERATIONS.
19. ADJUST TO GRADE MANHOLES, CATCH BASINS, VALVES, AND UTILITY CASTINGS IN PUBLIC RIGHTS-OF-WAY OR EASEMENTS AFTER PAVING.

STORM DRAINAGE NOTES (SD):

SD1. INSTALL CITY PROVIDED "NO DUMPING" MEDALLIONS AT ALL CURBSIDE STORM DRAIN INLETS.

SD2. PRIOR TO FINAL INSPECTION, CLEAN AND FLUSH STORM DRAIN PIPES AND VACTOR OUT STRUCTURES TO REMOVE SEDIMENT, TRASH, DEBRIS AND RUBBLE. DO NOT DISCHARGE WASH WATER TO ANY STORM DRAIN SYSTEM OR TO SURFACE WATERS.

SD3. ALL PIPE LENGTHS, INVERTS, INVERT ELEVATIONS AND DRAINAGE STRUCTURE LOCATIONS ARE MEASURED AT THE CENTER OF THE DRAINAGE STRUCTURE UNLESS OTHERWISE NOTED.

TEMPORARY EROSION AND SEDIMENT CONTROL (TESC) NOTES:

1. THE CONTRACTOR SHALL PROTECT ALL PUBLIC AND PRIVATE DRAINAGE SYSTEMS FROM POLLUTION. NO VISIBLE OR OTHERWISE MEASURABLE SEDIMENT OR POLLUTANT SHALL BE DISCHARGED TO, OR DEPOSITED INTO ANY WATER BODY OR STORM DRAINAGE SYSTEM ON PUBLIC OR PRIVATE PROPERTY.
2. THE CONTRACTOR SHALL COMPLY WITH ALL LOCAL, STATE, AND FEDERAL WATER QUALITY AND OTHER APPLICABLE EROSION AND SEDIMENT CONTROL STANDARDS.
3. THE CONTRACTOR IS RESPONSIBLE FOR INSTALLING, MAINTAINING, MONITORING, REPLACING AND/OR UPGRADING (AS NEEDED) EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMPs) TO ENSURE THAT SEDIMENT OR OTHER POLLUTANTS DO NOT ENTER THE STORM DRAINAGE SYSTEM. SUCH BMPs INCLUDE SILT FENCE, STRAW WATTLES, FILTER FABRIC PROTECTION OF CATCH BASINS, PROTECTION OF DRAINAGE DITCHES, AND OTHER MEASURES AS REQUIRED.
4. THE CONTRACTOR SHALL PERFORM PERIODIC VISUAL MONITORING OF WATER BODIES AND/OR STORM DRAINAGE SYSTEMS IMMEDIATELY DOWNSTREAM OF WORK AREAS TO CONFIRM EFFECTIVENESS OF EROSION AND SEDIMENT CONTROL BMPs INSTALLED.
5. PRIOR TO LEAVING A DISTURBED SITE FOR A PERIOD LASTING OVERNIGHT OR LONGER, THE CONTRACTOR SHALL INSTALL AND/OR SECURE EROSION AND SEDIMENT CONTROL BMPs APPROPRIATE FOR WET WEATHER CONDITIONS, INCLUDING (BUT NOT LIMITED TO) STABILIZATION OF ANY EXPOSED SOILS.
6. THE CONTRACTOR SHALL ENSURE ALL CHEMICAL OR HAZARDOUS MATERIALS ARE CONTAINED AND HANDLED APPROPRIATELY. NO CHEMICAL OR HAZARDOUS MATERIAL SHALL BE DISCHARGED TO THE STORM DRAIN SYSTEM.
7. AFTER COMPLETION OF CONSTRUCTION AND WITH APPROVAL OF THE CITY ENGINEER, THE CONTRACTOR SHALL (1) ENSURE THAT APPROPRIATE LONG-TERM EROSION AND SEDIMENT CONTROL BMPs ARE IN PLACE, AND (2) REMOVE ANY BMPs NO LONGER NEEDED.

TEMPORARY BYPASS NOTES:

1. CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL FIELD CONDITIONS, INCLUDING STORM DRAIN SYSTEM COMPONENTS AND LOCATIONS, PRIOR TO STARTING ANY TEMPORARY BYPASS PUMPING.
2. TEMPORARY BYPASS PUMPING SYSTEM BE SIZED FOR TO CONVEY MAXIMUM FLOWS THROUGH THE PORTION OF THE EXISTING STORM DRAINAGE SYSTEM BEING BYPASSED.
3. A MINIMUM OF ONE (1) SUFFICIENTLY-SIZED STANDBY PUMP PER ACTIVE WORK LOCATION SHALL BE AVAILABLE ON STANDBY AT ALL TIMES.
4. DIESEL GENERATORS AND DIESEL-DRIVEN PUMPS SHALL BE OPERATED ONLY WHEN CONTAINMENT MEASURES ARE IN PLACE TO PREVENT OIL AND/OR FUEL SPILLS.
5. BYPASSED FLOWS SHALL BE RETURNED TO THE SAME STORMWATER SYSTEM THAT THEY ARE DIVERTED FROM, AND SHALL BE RETURNED TO THAT SYSTEM AT THE NEAREST AVAILABLE LOCATION DOWNSTREAM FROM THE WORK AREA.
6. CONTRACTOR SHALL ENSURE THAT THE BYPASS SYSTEM DOES NOT INTRODUCE ANY CONTAMINANTS OR TURBIDITY INTO THE STORMWATER.
7. CONTRACTOR SHALL USE SANDBAGS, ROCK, AND/OR OTHER MEASURES TO ENSURE THAT ANY BYPASS PUMP SYSTEM INTAKES AND OUTFALLS LOCATED WITHIN DITCHES OR OTHER LANDSCAPED SURFACES DO NOT CAUSE EROSION OR OTHER DAMAGE TO THESE AREAS.
8. BYPASS SYSTEM TO REMAIN ACTIVE FOR THE FULL DURATION REQUIRED BY THE WORK, INCLUDING OUTSIDE OF WORKING HOURS IF NECESSARY.

UTILITY PROTECTION NOTES:

1. CONTRACTOR SHALL EXERCISE CARE WHILE EXCAVATING AND PERFORMING OTHER WORK NEAR ANY UTILITY INFRASTRUCTURE, INCLUDING ABOVE GROUND, OVERHEAD, AND UNDERGROUND FACILITIES.
2. FOR ANY EXCAVATION WITHIN 3 FEET OF EXISTING UNDERGROUND UTILITY LOCATIONS, THE CONTRACTOR SHALL PROTECT EXISTING UTILITY AND EXCAVATE WITH EXTREME CAUTION IN PROXIMITY. CONTACT UTILITY COMPANY (SEE SHEET CV1). LOCATIONS WHICH WERE IDENTIFIED DURING CONSTRUCTION WERE POTHOLED TO CONFIRM LOCATION OF THE UTILITY BEFORE BEGINNING WORK, SEE PLAN SHEETS AND POTHOLING DATA SHEETS IN CONTRACT PROVISION APPENDICES. DESIGN PHASE POTHOLING MAY NOT HAVE IDENTIFIED ALL SUCH UTILITIES, SO CONTRACTOR SHALL PROVIDE POTHOLING IN SUCH CASES.
3. ANY EXCAVATION WITHIN 2 FEET OF EXISTING GAS OR WATER INFRASTRUCTURE SHALL BE BY VACUUM EXCAVATION. SEE PLAN SHEETS.
4. ADDITIONAL PROCEDURES FOR WORKING IN PROXIMITY TO SEATTLE PUBLIC UTILITY (SPU) INFRASTRUCTURE

   4.1. CONTRACTOR SHALL NOT REPAIR DAMAGE TO CHARGED WATER MAINS OR SERVICES, BUT SHALL IMMEDIATELY NOTIFY THE SPU EMERGENCY DISPATHER AT (206) 386-1800.

   4.2. IF A CAST IRON PIPE (CIP) PIPE BELL IS EXPOSED DURING CONSTRUCTION, CONTRACTOR SHALL CONTACT SPU EMERGENCY DISPATCHER AT (206) 386-1800. A CREW WILL BE DISPATCHED TO INSPECT THE BELL AND DETERMINE IF IT SHOULD BE RE-CAULKED.

   4.3. WHEN CROSSING EXISTING UTILITIES, A CONTRACTOR SHALL MAINTAIN 18" MINIMUM VERTICAL CLEARANCE FROM OUTSIDE WALL OF ALL SPU FACILITIES TO THE OUTSIDE WALL OF THE PROPOSED LINE, UNLESS OTHERWISE DIRECTED BY THE ENGINEER.

   4.4. WHEN EXCAVATING UNDER SPU WATER MAINS, CONTRACTOR SHALL SUBMIT A WATER MAIN SUPPORT AND PROTECTION PLAN. THE PLAN SHALL SHOW HOW THE PIPE WILL BE SUPPORTED AND METHOD OF EXCAVATION AROUND THE PIPE.

TRAFFIC CONTROL (TC) GENERAL NOTES:

TC.1. INTERIM TRAFFIC CONTROL: THE CONTRACTOR SHALL BE RESPONSIBLE FOR INTERIM TRAFFIC CONTROL DURING CONSTRUCTION ON OR ALONG TRAVELED CITY ROADS. REFER TO SPECIAL PROVISION SECTION 1-10.2(2) FOR REQUIREMENTS REGARDING TRAFFIC CONTROL PLANS.

TC.2. TRAFFIC CONTROL SHALL FOLLOW THE GUIDELINES OF SECTION 1-07.23 OF THE WSDOT/APWA STANDARD SPECIFICATIONS.

TC.3. ALL BARRICADES, SIGNS AND FLAGGING SHALL CONFORM TO THE REQUIREMENTS OF THE MUTCD. FOR MORE SPECIFIC REQUIREMENTS FOR BARRICADES, SEE SECTION 5.7 AND DRAWING NO. 5-003 OF KING COUNTY ROAD STANDARDS. SIGNS MUST BE LEGIBLE AND VISIBLE AND SHALL BE REMOVED AT THE END OF EACH WORK DAY IF NOT APPLICABLE AFTER CONSTRUCTION HOURS.

TC.4. TEMPORARY ROAD CLOSURES AND DETOURS: WHEN CITY AGREES THAT TEMPORARY ROAD CLOSURES CANNOT BE AVOIDED THE CONTRACTOR SHALL POST "TO BE CLOSED" SIGNS A MINIMUM OF FIVE DAYS PRIOR TO THE CLOSURE. THE TYPES AND LOCATIONS OF THE SIGNS SHALL BE SHOWN ON A DETOUR PLAN. A DETOUR PLAN MUST BE PREPARED AND SUBMITTED TO THE CITY OF SHORELINE PLANNING AND DEVELOPMENT SERVICES DEPARTMENT AT LEAST 10 WORKING DAYS IN ADVANCE, AND APPROVED PRIOR TO CLOSING ANY CITY ROAD. IN ADDITION, THE CONTRACTOR MUST NOTIFY, IN WRITING, LOCAL FIRE, SCHOOL, LAW ENFORCEMENT AUTHORITIES, METRO TRANSIT, AND ANY OTHER AFFECTED PERSONS AS DIRECTED BY THE ENGINEER AT LEAST FIVE DAYS PRIOR TO CLOSING.

TC.5 ANY INTERRUPTION OF NORMAL TRAFFIC FLOW SHALL REQUIRE TRAFFIC CONTROL - INCLUDING BUT NOT LIMITED TO FLAGGING - WHICH SHALL BE MAINTAINED BY THE CONTRACTOR FOR THE DURATION OF TRAFFIC IMPACT.

TC.6 CONTRACTOR SHALL PROTECT EXISTING TRAFFIC CONTROL SIGNS WITHIN THE LIMITS OF WORK.

TC.7 ALL SITES MUST REVERT TO PASSIVELY FUNCTIONAL (NO FLAGGERS NEEDED, ETC) TRAFFIC LANE CONFIGURATIONS OUTSIDE OF WORK HOURS EXCLUDING WHEN ROAD IS CLOSED FOR CULVERT CONSTRUCTION.

TC.8 MINIMIZE ACCESS IMPACTS TO DRIVEWAYS. CONTRACTOR SHALL NOT BLOCK ANY DRIVEWAY WITHOUT HAVING OBTAINED PRIOR APPROVAL FROM RESIDENT. CONTRACTOR SHALL RESTORE DRIVEWAY ACCESS AT THE END OF EACH WORKING DAY.

TREE PROTECTION NOTES (TP):

1. BEFORE ANY CLEARING OR GRADING OCCURS INSTALL TREE PROTECTION AS REQUIRED.
2. DO NOT ALLOW FILL, EXCAVATION, THE STORAGE OF TOOLS, EQUIPMENT, CONSTRUCTION MATERIALS OR STOCKPILE OIL, OR TRAFFIC OR UTILITY CONSTRUCTION INCLUDING IRRIGATION SYSTEMS WITHIN THE DRIP-LINE AREAS OF TREES THAT ARE TO BE RETAINED EXCEPT AS SHOWN ON THE PLANS.
3. PROTECT AS MUCH OPEN SOIL SURFACE BELOW THE TREE'S CROWN AS POSSIBLE.
4. WHEN TRENCHING WITHIN THE ROOT ZONE OF PROTECTED TREES, THE FOLLOWING PROCEDURE MUST BE FOLLOWED:
   4.A. TO THE MAXIMUM EXTENT POSSIBLE, THE HOE SHOULD BE OPERATED TO "COMB" THE MATERIAL IN A DIRECTION AWAY FROM THE TRUNK, AS OPPOSED TO CUTTING ACROSS THE ROOTS.
   4.B. TUNNEL UNDER ROOTS GREATER THAN 1" DIAMETER. CLEANLY CUT ANY TORN ROOTS TO THE EDGE OF THE TRENCH. COVER EXPOSED ROOTS WITH VISQUEEN OR LIKE MATERIAL AND KEEP MOIST DURING OPEN GROUND PROCEDURES
   4.C. IF ANY ROOTS OF ONE INCH DIAMETER OR GREATER OF THE TREE ARE ACCIDENTALLY DAMAGED BY THE EQUIPMENT, STOP EQUIPMENT OPERATION AND EXCAVATE AROUND THE TREE ROOT BY HAND/SHOVEL AND CLEAN CUT DAMAGED PORTIONS OF THE TREE ROOT WITH LOPPER OR PRUNING SAW. EQUIPMENT OPERATION CAN RESUME, WORKING CAREFULLY AROUND EXPOSED LARGE ROOTS TO BE PROTECTED.
5. INSTALL FLOW DIVERSION MEASURES OUTSIDE OF THE CRITICAL ROOT ZONE OF TREES TO BE PROTECTED. AT NO TIME SHALL CONSTRUCTION STORMWATER BE DIRECTED TOWARD TREES TO BE PROTECTED. CONSTRUCTION STORMWATER SHALL NOT POND WITHIN A TREE'S CRITICAL ROOT ZONE.
6. CONCRETE TRUCKS SHALL NOT DEPOSIT WASTE OR WASH OUT MATERIALS FROM THEIR TRUCKS WITHIN THE TREE PROTECTION ZONE OR AREAS THAT DRAIN TO THE TREE PROTECTION ZONE.
7. ALL TREE WORK, INCLUDING ROOT PRUNING SHALL CONFORM TO CURRENT ADOPTED STANDARDS OF THE AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI) A300. ALL TREE PRUNING SHALL COMPLY WITH THE CURRENT SAFETY STANDARDS ANSI 2133.1 FOR PRUNING.
8. DO NOT ALLOW FILL, EXCAVATION, THE STORAGE OF TOOLS, EQUIPMENT, CONSTRUCTION MATERIALS OR STOCKPILE SOIL OR TRAFFIC OR UTILITY CONSTRUCTIOIN INCLUDING IRRIGATION SYSTEMS WITHIN THE DRIP-LINE AREAS OF TREES THAT ARE TO BE RETAINED.

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CORRECTED BY: / DATE:
VERIFIED BY: / DATE:

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE. IF NOT ONE INCH SCALE ACCORDINGLY

811 Know what's below. Call before you dig.

HERRERA

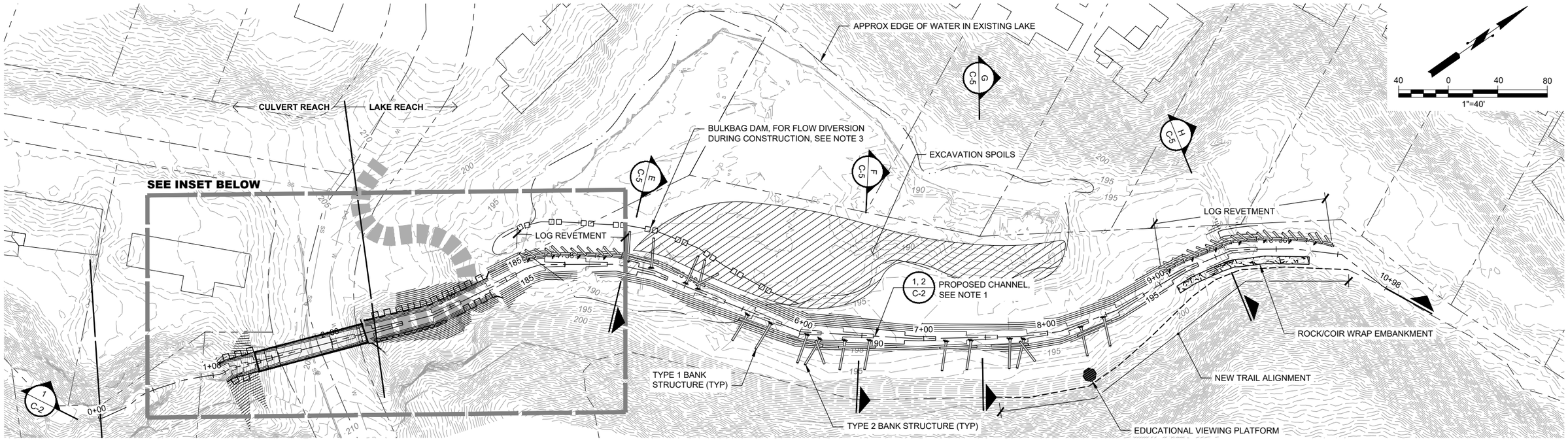
IAN R. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER — DRAFT

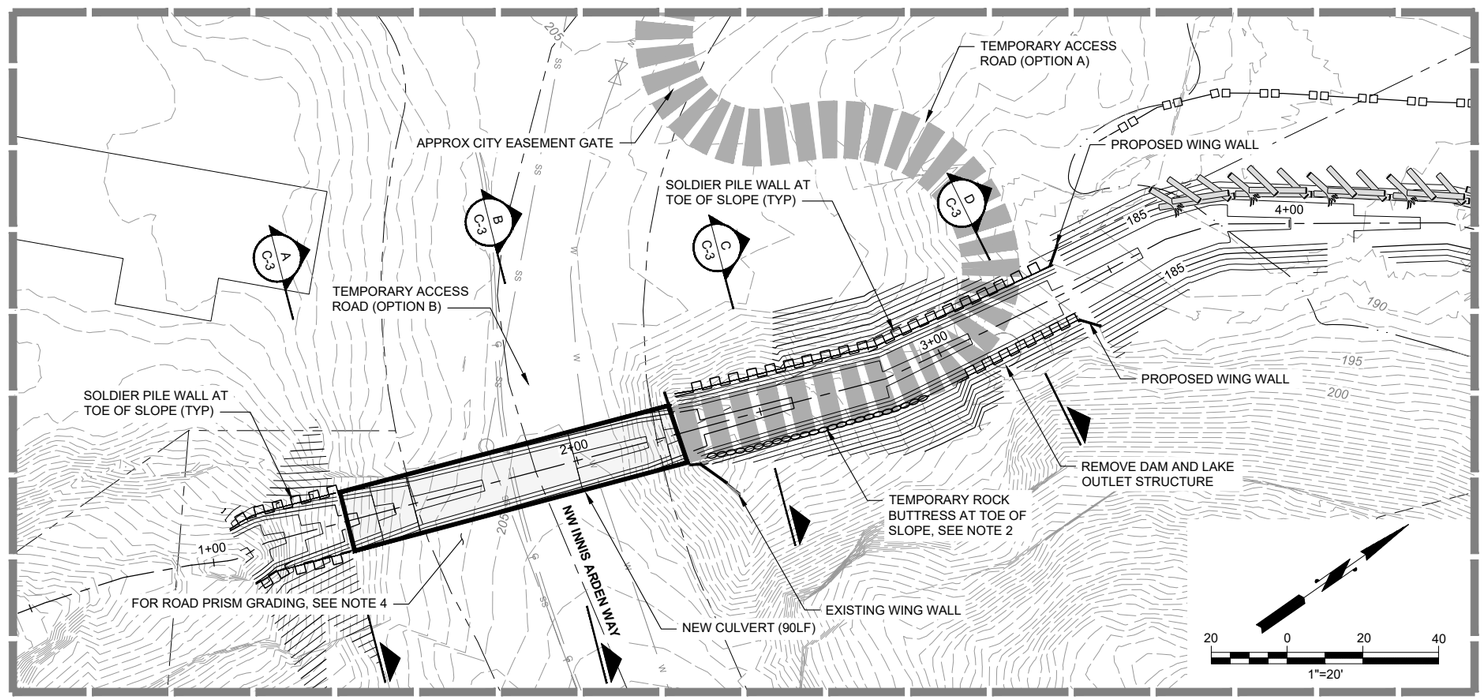
DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL		
DESIGNED: V. WU	DRAWN: -		
DESIGNED: -	CHECKED: -		
SCALE: AS NOTED	APPROVED: M. EWBANK		

HIDDEN LAKE
DAM REMOVAL CONCEPTUAL DESIGN

GENERAL NOTES

DATE: JANUARY 2018
PROJECT NO: 15-05984-000
DRAWING NO: G-2
SHEET NO: 2 OF 7





NOTES:

1. MEANDER STREAM CENTERLINE WITHIN THE CORRIDOR AS DIRECTED BY THE ENGINEER.
2. PLACE TEMPORARY ROCK BUTTRESS IF LAKE REACH IS CONSTRUCTED BEFORE CULVERT REACH.
3. FLOW BYPASS INDICATED IN THE 1995 KING COUNTY HIDDEN LAKE RESTORATION PLAN SET MAY BE USED FOR FLOW DIVERSION IF IT IS INTACT AND FUNCTIONAL.
4. GRADED CONTOURS NOT SHOWN. EXTENT OF ROAD PRISM GRADING WILL DEPEND ON WHETHER OPTION A OR OPTION B IS SELECTED. SEE SECTION A ON DRAWINGS C-3 AND C-4.

LEGEND:

- PARCEL LINE
- 100 EXISTING CONTOURS
- 100 PROPOSED CONTOURS
- EXISTING TRAIL (APPROX LOCATION)

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CORRECTED BY: / DATE:
VERIFIED BY: / DATE:
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CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

811 Know what's below. Call before you dig.

HERRERA

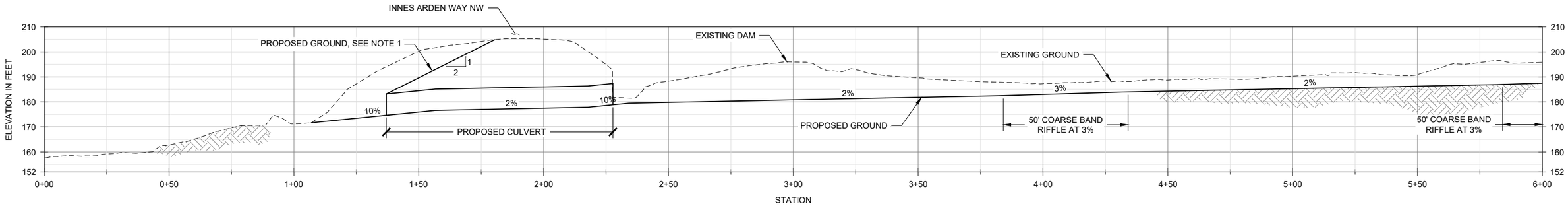
DRAFT

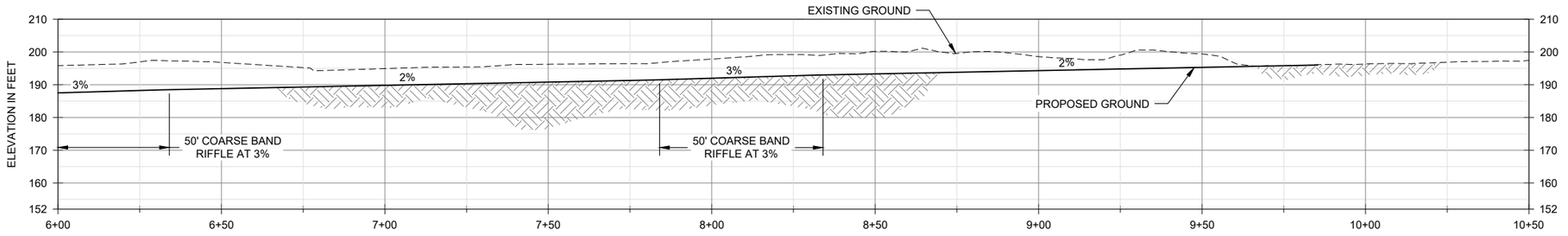
DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL
DESIGNED: V. WU	DRAWN: -
DESIGNED: -	CHECKED: -
SCALE: AS NOTED	APPROVED: M. EWBANK

HIDDEN LAKE
DAM REMOVAL CONCEPTUAL DESIGN

SITE PLAN

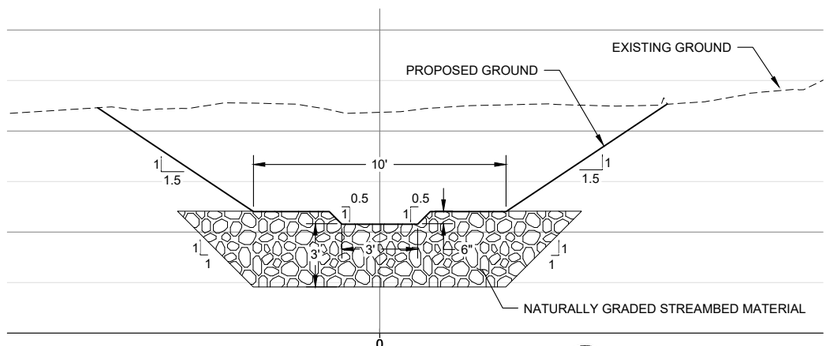
DATE:	JANUARY 2018
PROJECT NO:	15-05984-000
DRAWING NO:	C-1
SHEET NO:	3 OF 7





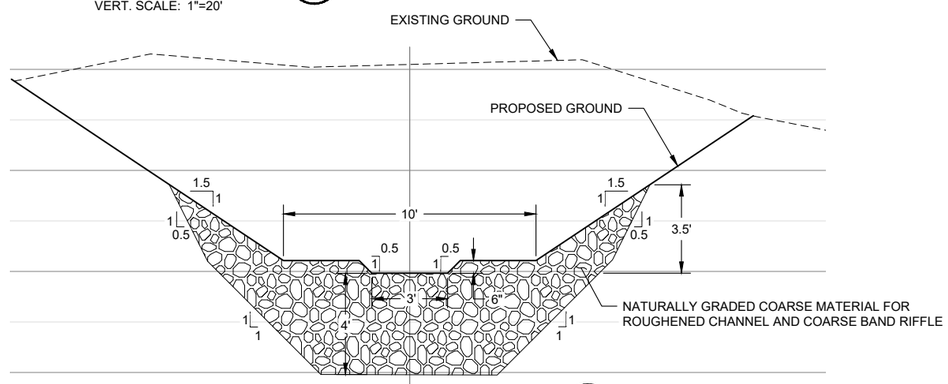
PROFILE - CHANNEL (1 / C-1)

HORIZ. SCALE: 1"=20'
VERT. SCALE: 1"=20'



DETAIL - TYPICAL CHANNEL AT 2% (1 / C-1)

SCALE: NTS



DETAIL - TYPICAL CHANNEL > 2% (2 / C-1)

SCALE: NTS

NOTES:

1. UTILITIES MAY NEED TO BE REALIGNED TO ACCOMMODATE PROPOSED GRADING. EXTENT OF GRADING WILL VARY. SEE NOTE 4 ON DRAWING C-1.

LEGEND:

EXISTING SUBGRADE

STREAMBED SEDIMENT

ORIGINATED BY: / DATE:
CHECKED BY: / DATE:
BACK-CHECKED BY: / DATE:
CORRECTED BY: / DATE:
VERIFIED BY: / DATE:

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CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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HERRERA

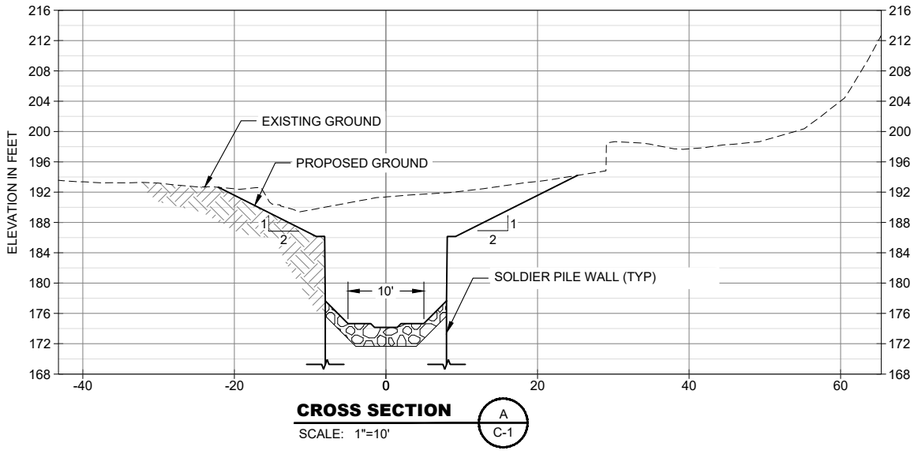
JAMES I. MOSTRENKO — STATE OF WASHINGTON — 36069 — REGISTERED PROFESSIONAL ENGINEER — DRAFT

DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL		
DESIGNED: V. WU	DRAWN: -		
DESIGNED: -	CHECKED: -		
SCALE: AS NOTED	APPROVED: M. EWBANK		

HIDDEN LAKE
DAM REMOVAL CONCEPTUAL DESIGN

CHANNEL PROFILE

DATE: JANUARY 2018
PROJECT NO: 15-05984-000
DRAWING NO: C-2
SHEET NO: 4 OF 7

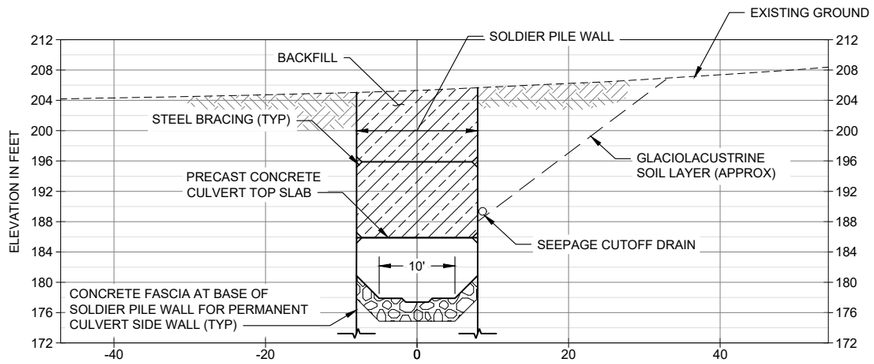


CROSS SECTION A / C-1

SCALE: 1"=10'

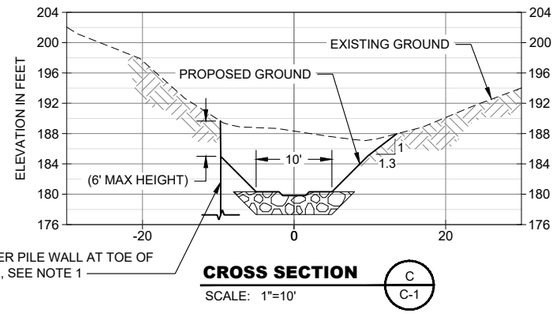
TYPICAL SOLDIER PILE SHORING WALL

TYPICAL FISH PASSABLE CULVERT INSTALLATION



CROSS SECTION B / C-1

SCALE: 1"=10'



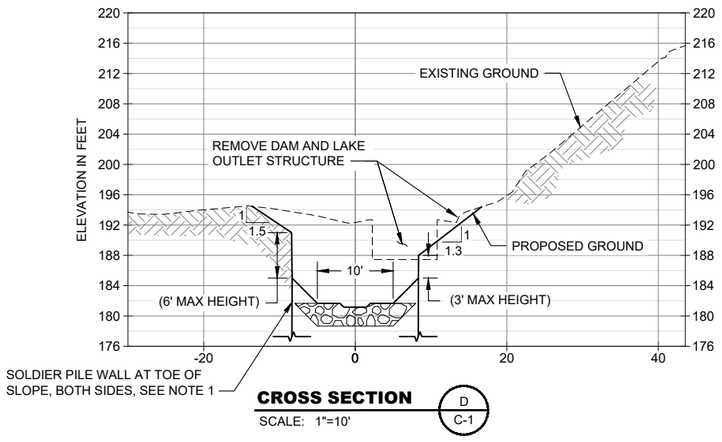
SOLDIER PILE WALL AT TOE OF SLOPE, SEE NOTE 1

CROSS SECTION C / C-1

SCALE: 1"=10'

CITY OF BELLEVUE COAL CREEK PARKWAY PROJECT
TYPICAL CHANNEL THROUGH CULVERT

TYPICAL SOLDIER PILE WALL AT TOE OF SLOPE



SOLDIER PILE WALL AT TOE OF SLOPE, BOTH SIDES, SEE NOTE 1

CROSS SECTION D / C-1

SCALE: 1"=10'

NOTES:

1. SOLDIER PILE WALL USED FOR EXCAVATION SHORING AND PERMANENT CULVERT WALLS. DEPTH OF SHORING NOT SHOWN AND WILL BE DETERMINED AS PART OF FINAL DESIGN.

LEGEND:

EXISTING SUBGRADE

STREAMBED SEDIMENT

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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HERRERA

IAN R. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER DRAFT

DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL		
DESIGNED: V. WU	DRAWN: -		
DESIGNED: -	CHECKED: -		
SCALE: AS NOTED	APPROVED: M. EWBANK		

HIDDEN LAKE

DAM REMOVAL CONCEPTUAL DESIGN

CHANNEL CROSS SECTIONS - CULVERT REACH OPTION A (VERTICAL SHORING WALLS WITH CAST-IN-PLACE CULVERT)

DATE: JANUARY 2018

PROJECT NO: 15-05984-000

DRAWING NO: C-3

SHEET NO: 5 OF 7

ORIGINATED BY: / DATE:

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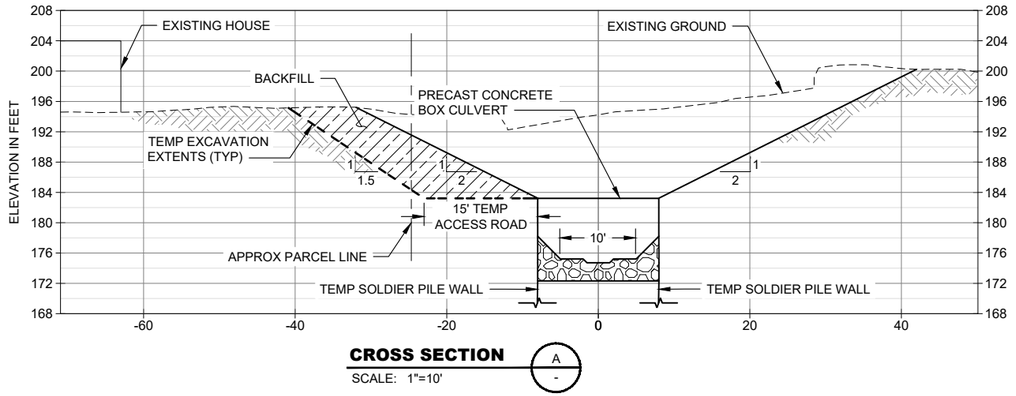
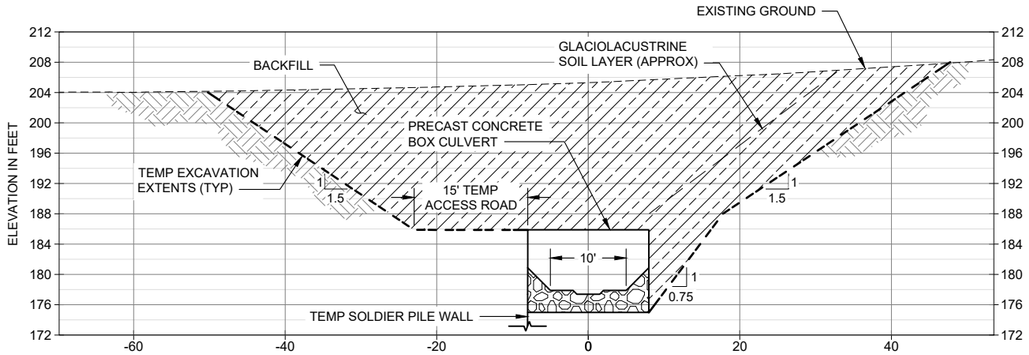
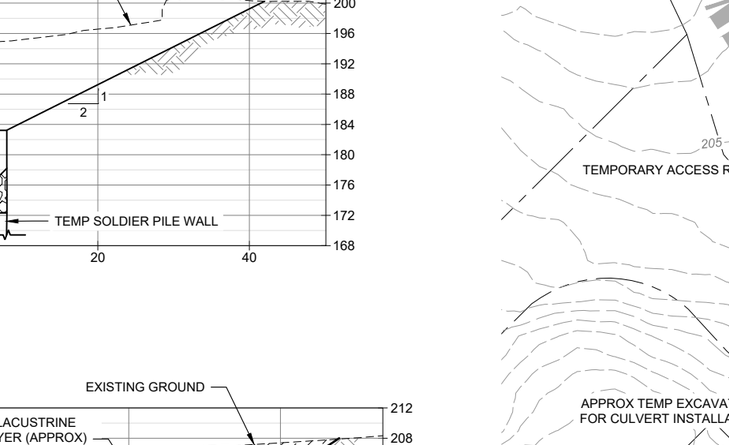


CROSS SECTION A
SCALE: 1"=10'

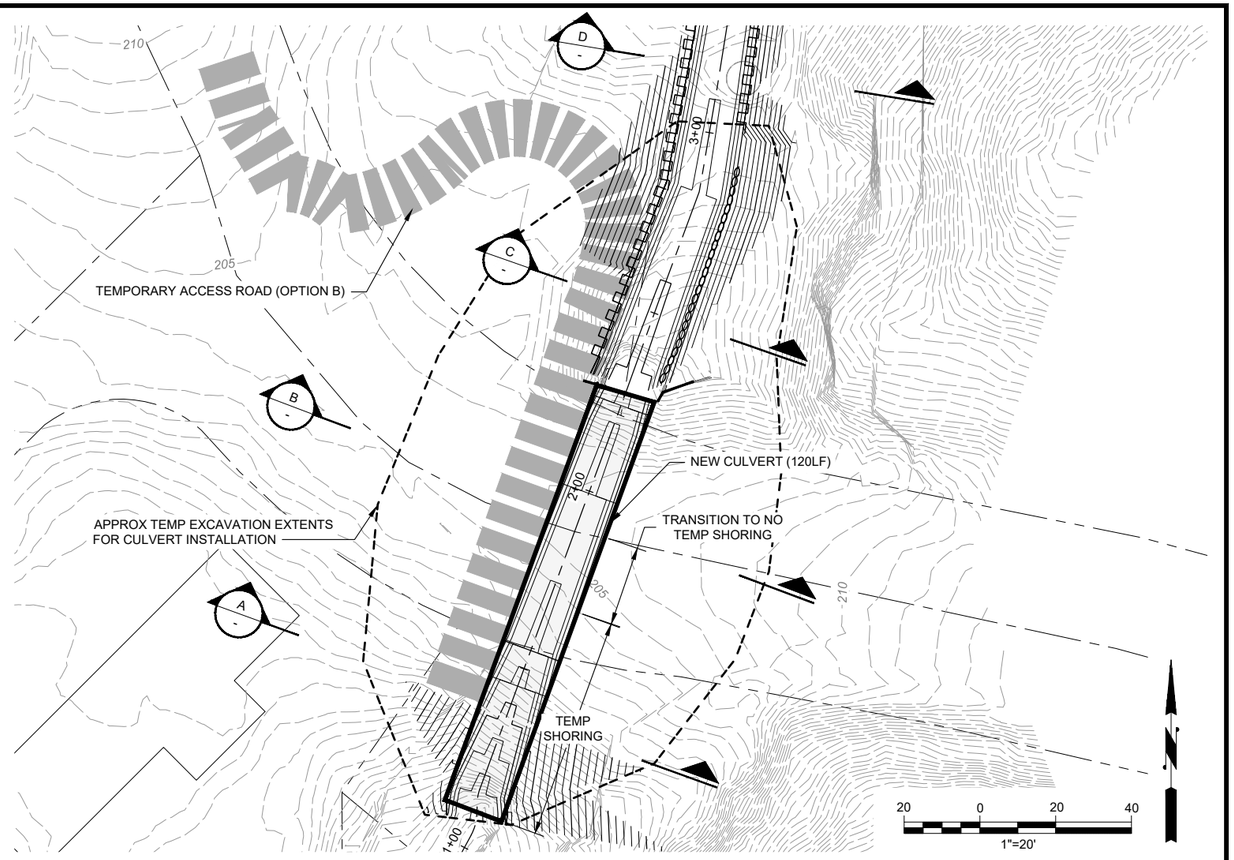


CROSS SECTION B
SCALE: 1"=10'

CROSS SECTION C
SCALE: 1"=10'



CROSS SECTION D
SCALE: 1"=10'



NOTES:

1. SOLDIER PILE WALL USED FOR EXCAVATION SHORING AND PERMANENT CULVERT WALLS. DEPTH OF SHORING NOT SHOWN AND WILL BE DETERMINED AS PART OF FINAL DESIGN.

LEGEND:

EXISTING SUBGRADE

STREAMBED SEDIMENT

TYPICAL PRECAST BOX CULVERT INSTALLATION

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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HERRERA

IAN B. MOSTRENKO STATE OF WASHINGTON 36069 REGISTERED PROFESSIONAL ENGINEER

DRAFT

DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL		
DESIGNED: V. WU	DRAWN: -		
DESIGNED: -	CHECKED: -		
SCALE: AS NOTED	APPROVED: M. EWBANK		

HIDDEN LAKE
DAM REMOVAL CONCEPTUAL DESIGN

CHANNEL CROSS SECTIONS - CULVERT REACH OPTION B
(SLOPED EXCAVATION WITH PRECAST BOX CULVERT)

DATE: JANUARY 2018
PROJECT NO: 15-05984-000
DRAWING NO: C-4
SHEET NO: 6 OF 7

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VERIFIED BY: / DATE:

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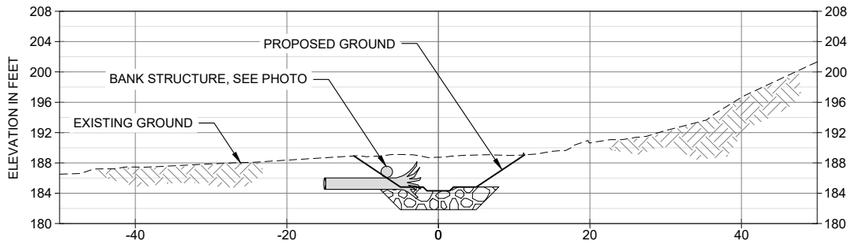
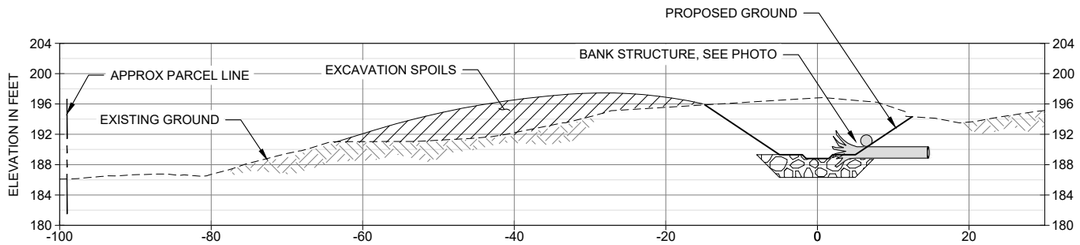
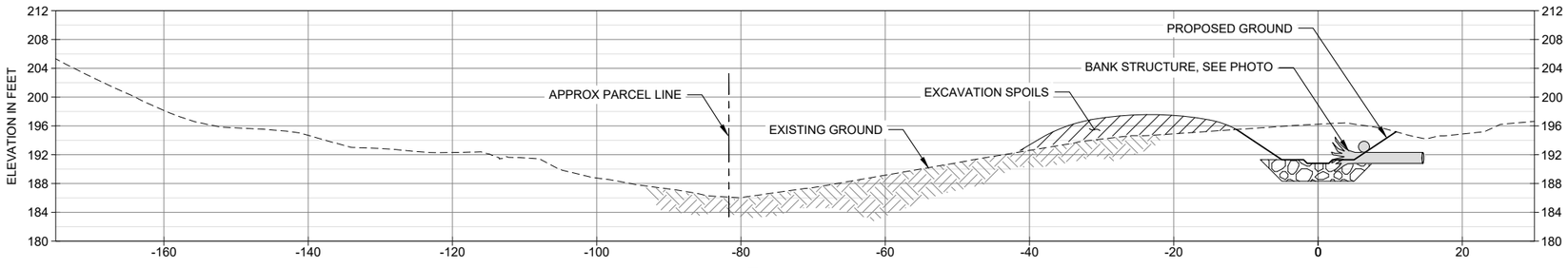


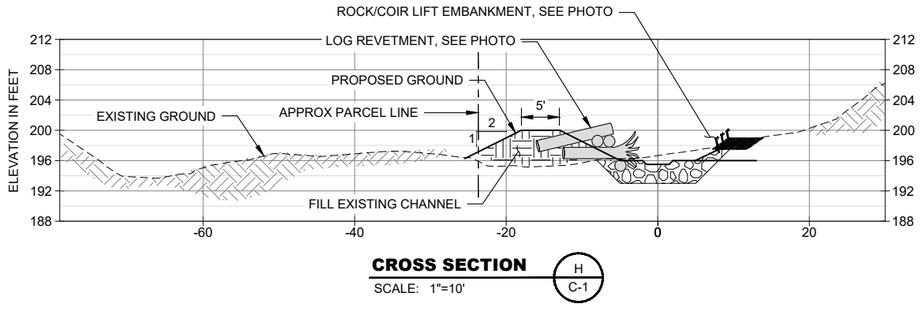
CROSS SECTION E / C-1
SCALE: 1"=10'



CROSS SECTION F / C-1
SCALE: 1"=10'



CROSS SECTION G / C-1
SCALE: 1"=10'



CROSS SECTION H / C-1
SCALE: 1"=10'

TYPICAL BANK STRUCTURE

TYPICAL LOG REVETMENT

TYPICAL ROCK/COIR WRAP EMBANKMENT

LEGEND:

- EXISTING SUBGRADE
- STREAMBED SEDIMENT
- SELECT BERM FILL

CONCEPTUAL DESIGN - NOT FOR CONSTRUCTION

No.	REVISION	BY	APP'D	DATE

ONE INCH AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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HERRERA

IAN B. MOSTRENKO STATE OF WASHINGTON 56069 REGISTERED PROFESSIONAL ENGINEER

DRAFT

DESIGNED: I. MOSTRENKO	DRAWN: E. MARSHALL
DESIGNED: V. WU	DRAWN: -
DESIGNED: -	CHECKED: -
SCALE: AS NOTED	APPROVED: M. EWBANK

HIDDEN LAKE
DAM REMOVAL CONCEPTUAL DESIGN

CHANNEL CROSS SECTIONS - LAKE REACH

DATE: JANUARY 2018
PROJECT NO: 15-05984-000
DRAWING NO: C-5
SHEET NO: 7 OF 7

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APPENDIX B

Geotechnical Analysis Memorandum

HWA GeoSciences Inc.
Geotechnical & Pavement Engineering • Hydrogeology • Geoenvironmental • Inspection & Testing

February 1, 2018
HWA Project No. 2017-096-21

Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121

Attention: Mr. Mark Ewbank, P.E.

SUBJECT: PRELIMINARY GEOTECHNICAL REPORT
HIDDEN LAKE DAM REMOVAL AND STREAM RESTORATION PROJECT
Shoreline, Washington

Dear Mark:

This letter report presents the results of our geologic and geotechnical evaluation for the Hidden Lake Dam Removal and Stream Restoration project in Shoreline, Washington. Herein we provide our interpretations of geology and geomorphology of the project site; preliminary geotechnical recommendations regarding slope stability, temporary shoring, subgrade for structures, and earthwork for removal of the dam north of Innis Arden Way; and replacement of the culverts beneath Innis Arden Way.

PROJECT SCOPE AND AUTHORIZATION

Our work was performed in general accordance with our proposal letter dated September 12, 2017. Written authorization to proceed was provided by Mark Ewbank in an e-mail on October 3, 2017. Our work thus far has consisted of review of previous subsurface exploration data, geologic and geomorphic reconnaissance of the slopes, drilling four borings, evaluating conceptual design considerations for dam removal and replacement of the culverts beneath the road, and preparation of this preliminary geotechnical report.

PROJECT BACKGROUND

We understand the City of Shoreline is exploring the option to remove the existing dam that has created Hidden Lake. Along with dam removal, preliminary design is also considering the feasibility of replacing the existing twin 48-inch diameter reinforced concrete culverts below Innis Arden Way with a larger, fish-friendly box culvert.

The site is located within the Boeing Creek valley at the southern end of Hidden Lake, west of Shoreline Community College and Shoreview Park (see Figure 1).

21312 30th Drive SE
Suite 110
Bothell, WA 98021.7010

Tel: 425.774.0106
Fax: 425.774.2714
www.hwageo.com

We understand the lake was initially created as an amenity to the Boeing estate by damming Boeing Creek. During the 1950s to 1970s development upstream of the lake resulted in greater storm water flows leading to persistent erosion issues. The original earthen dam failed, and the lake had filled with sediment by the 1970s. In 1996, King County rebuilt the dam and recreated the lake. In 1997, a sinkhole formed due to ruptured sewer lines near 175th Street and the lake filled in with sediment again requiring that the lake be re-excavated. The lake has been maintained since then; however, sediment deposition into the lake has been of the order of a thousand cubic yards per year. The City has elected to stop dredging to maintain the lake. Without periodic removal of sediment, the lake will fill with sediment and could impact other utilities and the infrastructure in the road. To mitigate these risks, the City is exploring the options for removing the dam and upsizing and/or lowering the culverts that flow under Innis Arden Way.

FIELD INVESTIGATION

HWA performed a reconnaissance of the site to assess the stability of slopes and evaluate surficial soil conditions in the vicinity of the dam and culvert. The depths of weathered soil on slopes (colluvium) were determined at selected locations using a ½-inch diameter steel T-handled probe. Observations were made of soil exposures, seepage zones and other features indicating relative slope stability.

Two boreholes (designated BH-1 and BH-2) were drilled on the slope east of the culverts downstream of the dam on October 31, 2017. Drilling was performed by Geologic Drill Explorations, Inc. under subcontract to HWA. They were drilled with a Bobcat Mini-track drill rig to depths of 31.5 feet. Two additional boreholes (designated BH-3 and BH-4) were drilled within the Innis Arden Way road prism on November 9, 2017 by Environmental Drilling, Inc. also under subcontract to HWA. These were drilled with a truck-mounted Mobile B-61 rig to depths of 49 feet. Locations of the borings, along with previous borings by others, are shown on the Site and Exploration Plan, Figure 2.

Soil samples were collected at 2½- to 5-foot depth intervals using Standard Penetration Test (SPT) sampling methods. SPT testing consisted of using a 2-inch outside diameter, split-spoon sampler driven with a 140-pound hammer. For BH-1 and BH-2, the SPT was performed using a rope and cathead with safety hammer. For BH-3 and BH-4, the SPT was performed using an automatic hammer. During the test, each sample was obtained by driving the sampler up to 18 inches into the soil with the hammer free-falling 30 inches per blow. The number of blows required for each 6 inches of penetration was recorded. The standard penetration resistance of the soil was calculated as the number of blows required for the final 12 inches of penetration. If a total of 50 blows was recorded within a single 6-inch interval, the test was terminated, and the blow count was recorded as 50 blows/number of inches of penetration. This resistance provides

an indication of the relative density of granular soils and the relative consistency of cohesive soils.

All explorations were drilled under the full-time supervision and observation of an HWA engineering geologist or geotechnical engineer. Soil samples obtained from the explorations were classified in the field and representative portions were placed in plastic bags. These soil samples were then taken to our Bothell, Washington, laboratory for further examination.

Pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and ground water occurrence was recorded and used to develop logs of each of the explorations. A legend of the terms and symbols used on the borehole logs is presented on Figure A-1, and the logs are presented on Figures A-2 through A-5.

The stratigraphic contacts shown on the borehole logs represent the approximate boundaries between soil types. Actual transitions may be more gradual. The ground water conditions depicted are only for the specific dates and locations reported, and therefore, are not necessarily representative of other locations and times.

GENERAL GEOLOGIC CONDITIONS

The project is located within the Puget Lowland. The Puget Lowland has repeatedly been occupied by a portion of the continental glaciers that developed during the ice ages of the Quaternary period. During at least four periods, portions of the ice sheet advanced south from British Columbia into the lowlands of Western Washington. The southern extent of these glacial advances was near Olympia, Washington. Each major advance included numerous local advances and retreats, and each advance and retreat resulted in its own sequence of erosion and deposition of glacial lacustrine, outwash, till, and drift deposits. Between and following these glacial advances, sediments from the Olympic and Cascade Mountains accumulated in the Puget Lowland in lakes and valleys.

Geologic information for the project area was obtained from the *Geologic Map of the Edmonds East and part of the Edmonds West Quadrangles, Washington* (Minard, 1983). Per this map, near-surface deposits in the vicinity of the project alignment consist of soils associated with the Vashon Stade of the most recent continental glaciation (Fraser Glaciation). The geologic map indicates that the project area is underlain by Transitional Beds deposits, which consist of a combination of glaciolacustrine deposits and non-glacial lake deposits. Geomorphology of the Boeing Creek valley indicates it was cut through these deposits (and advance outwash and glacial till on higher slopes) by glacial outwash channels and subsequent non-glacial alluvial processes.

SUBSURFACE CONDITIONS

SOIL CONDITIONS

On the slope east of the creek, between the dam and Innis Arden Way, boreholes BH-1 and BH-2 encountered approximately 7½ feet of soft silt and clay with organics (colluvium) above and below fill closer to the dam (at BH-1) and alluvium closer to Innis Arden Way (at BH-2). These modern deposits were over very stiff to hard, clay and silt (glaciolacustrine deposits). This hard clay/silt unit is exposed in a 15-foot high bluff just above the colluvial slope explored by boreholes BH-1 and BH-2, and on both sides of the stream valley downstream of Innis Arden Way.

The borings within Innis Arden Way encountered from 12½ to 24 feet of fill over alluvium, then glaciolacustrine deposits to the full depths explored.

Descriptions of the soils are given below, and shown on the geologic cross sections (see Figures 3 and 4):

- **Colluvium:** Soft clay with organics and scattered sand was encountered at the ground surface in boreholes BH-1 and BH-2. This recent deposit consists of soils that have moved downslope due to processes of weathering (chemical, mechanical, and biological), gravity, and water. Further weathering of the slope above will add to the thickness of colluvium, with potential periodic slide events contributing material episodically.
- **Fill/Buried Topsoil:** Fill was observed in each of our borings, except BH-2. Boring BH-1 encountered a thin layer of fill above and below the colluvium. Roadway prism fill consisting of loose to medium dense, slightly silty to silty, sand with no to little gravel was encountered in borings BH-3 and BH-4. Below the fill in BH-4, a buried topsoil layer was observed.

  Also, previous borings at the dam by Perrone Consulting (2015; borings B-1 and B-2) encountered dam fill (placed in 1996) consisting of sandy lean clay and silty sand with gravel.
- **Alluvium:** Boreholes BH-3 and BH-4 encountered sand and gravel alluvium beneath the roadway fill, for a thickness ranging from approximately 3½ to 8 feet. This material was saturated and associated with perched ground water above the underlying glaciolacustrine deposits. Borehole BH-2 encountered a thin lens of alluvium sandwiched within the colluvium. Previous explorations also encountered alluvium to various depths, including below the slide debris.
- **Slide Debris:** Although we did not encounter this unit at the locations drilled for this study, previous borings (Shannon & Wilson, 1995) encountered suspected slide

debris toward the western portion of the dam location. This deposit consists of soft to medium stiff, fat clay and silty clay with slickensides and blocky texture.

- **Glaciolacustrine:** This unit consists of very stiff to hard, gray, silty clay, lean clay and fat clay. The glaciolacustrine deposits ranged from massive, to finely laminated, to disturbed with blocky texture. Within the fat clay observed between 31 to 47 feet in BH-3 and 37 to 47 feet in BH-4, slickensides were observed and are likely due to compression forces experienced during the Fraser Glaciation. Glaciolacustrine deposits typically have high shear strength and low permeability, with ground water often perched within more permeable materials on top of the glaciolacustrine deposits.

GROUND WATER CONDITIONS

Ground water was observed during drilling of BH-3 and BH-4, particularly within the alluvium. The highest ground water level in BH-4 was at a depth of 6 feet during drilling, which likely represents perched ground water within the silty fill. Ground water was encountered in most of the previous borings by others within 10 feet of the ground surface. We expect ground water levels will vary depending on location, season, and the relative abundance of precipitation.

CONCLUSIONS & RECOMMENDATIONS

GENERAL

Design for the proposed dam removal and stream restoration will require excavation of the existing materials at the dam and regrading of the slopes along the sides of the channel upstream of Innis Arden Way. Along with dam removal, the City of Shoreline is considering replacing the existing twin 48-inch culverts that flow under Innis Arden Way. The existing culverts would likely be replaced with a pre-cast concrete box structure.

The excavation for culvert replacement will be on the order of 30 feet deep and could be completed as an open cut excavation, although some shoring may be necessary at the base of the excavation. More extensive shoring, such as soldier piles and lagging may be necessary, but only where the excavation would otherwise extend onto adjacent properties or easements. The Contractor will be responsible to provide a safe excavation and design any shoring system used in the excavation.

Grading of the stream channel north of Innis Arden Way will likely require the use of wing walls or toe walls north of the box culvert. These could consist of cast-in-place or soldier pile and lagging walls. Sloping and stream bank stabilization should be provided to limit erosion of the permanent slopes once the dam is removed.

Other construction issues will be the protection of the existing 8-inch diameter sewer line that crosses the site in Innis Arden Way, control of seepage as needed, potential re-use of the excavated materials and protection of the subgrade once the excavation is completed.

EXCAVATION

Installation of the culvert and removal of the dam can likely be accomplished using open cut with minimal shoring. There appears to be adequate room along the west side of the culvert alignment to provide stable, sloped excavations. The dense native soils along the east side of the culvert are likely to be stable at relatively steep slopes after removal of the overlying loose colluvial soils. Where adequate room is not available, shoring such as soldier pile and lagging may be required to provide protection for workers.

The upper 15 feet to 30 feet of soils below Innis Arden Way consist of silty sand interpreted to be fill and alluvial soils. The fill is generally thicker on the west side of the culverts (32 feet in BH-4) when compared with the east side (17 feet in BH-3). These soils classify as Type C soils in accordance with Part N of the WAC 196-297 and can be sloped no steeper than 1.5H:1V to meet safety requirements for worker access during construction. Below the alluvium is very stiff to hard glaciolacustrine soils that classify as Type A soils and could be sloped as steep as 0:75H:1V. These slopes could be used to estimate the approximate extent of the proposed excavations to determine if there is adequate room for sloped excavations. For the depth of fill observed in BH-4, a horizontal distance of 45 feet measured from the edge of the excavation would be needed to provide a 1.5H:1V slope.

On the east side of the culvert, the dense glaciolacustrine soil is likely to stand nearly vertical for heights on the order of 15 feet or more, as observed by the vertical slope to the east of the existing dam. During construction, a geotechnical engineer could evaluate this cut slope as the soils are exposed to see if slopes steeper than ¾ H:1V could be used while still maintaining worker safety, which would reduce the extent of the open cut. Evaluation and monitoring during excavation is recommended as the depths of the contacts between fill, alluvium, and glaciolacustrine are expected to vary significantly over short distances and conditions may require some limited shoring as the subsurface soils are exposed. In future phases of the design, we recommend drilling explorations on the slope south of Innis Arden Way to provide additional data regarding the approximate depth of the glaciolacustrine layer along the culvert alignment.

Shored Excavation with Internal Bracing

Where an open excavation using the applicable slopes for the soil types will extend a significant distance onto adjacent properties or impact adjacent structures, it may be prudent to consider a more extensive shoring system for the excavation. Shoring could consist of vertical elements such as steel sheet piles or soldier piles and wood lagging and, where necessary, could include the use of internal bracing. Given the hardness of the glaciolacustrine soil, it may be difficult to drive steel sheets a sufficient depth into these soils. This would make soldier piles and lagging the preferred option for vertical shoring.

Soldier pile and lagging walls are typically constructed with 10- to 12-inch diameter H-piles spaced 6 to 8 feet apart along the wall alignment. The piles are placed in vertical drilled holes

and the holes are backfilled with lean concrete. Excavation is made on the inside of the shoring and lagging is installed between the flanges of the piles as the excavation proceeds. Lean concrete must be chipped away to allow lagging installation.

Pre-Cast Concrete Culvert Design

We anticipate that pre-cast concrete box culverts will be used for this project. The foundations of the culvert would be placed on the existing soils at the base of the excavation. Two culvert types are available, one being a four-sided box culvert and the other being a three-sided U-shaped culvert. The advantage of a four-sided box culvert is that it spreads out the load across the bottom of the culvert, reducing the bearing capacity required and limiting differential settlement if materials with differing properties are encountered at the subgrade. It also reduces the potential for scour to undermine the foundations. A U-shaped culvert would require casting a separate footing prior to placement of the precast sections and would be more susceptible to differential settlement, particularly if soft/loose soils are encountered at subgrade elevation along the culvert alignment. The advantage of a three-sided box culvert is that it could reduce the depth of the excavation needed for installation, although there would be potential for added excavation depth needed to encounter suitable subgrade soils. Potential for scour below the footings would also need to be considered.

SLOPES AND RETAINING WALLS

Retaining Walls Upstream of Culvert

Grading for dam removal and culvert installation is expected to deepen and widen the channel when compared with the grades of the site prior to installation of the dam in 1996. Although the existing slopes on the upstream end of the culverts are currently stable, we recommend that retaining walls be considered where additional cut into the surrounding slopes is proposed.

For wall construction, temporary cuts into the slopes could be allowed for forming and casting wing walls integrated into the culvert structure, much like the structure in place today. Where cutting into the existing slope even for a temporary excavation is not desired, soldier piles and lagging could be used.

Slope Grading on Side of Channel

For the purposes of determining permanent grades of the eastern slope north of Innis Arden Way, we evaluated the steepness of the side slopes that will be suitable for streambank stability. Based on the existing topography, the side slopes of the current channel range from 1H:1V to 1.3H:1V. These angles are consistent with our estimate of the angle of repose for the colluvial and alluvial materials observed at the site, indicating that the factors of safety for slope stability are near or slightly above one. To provide for long-term stability, we recommend that the maximum slope angle be 1.5H:1V. Stream bank stabilization measures should also be implemented to reduce scour so that undermining of the slope is reduced.

For the west side of the channel, we understand the City would like to minimize disturbance to this side of channel. The existing slope is at 1.5H:1V and is expected to be in a stable configuration provided walls are constructed where cuts are made into the toe of the slope and erosion protection of the slopes is provided.

RETAINING WALLS DOWNSTREAM OF CULVERT

Retaining walls could be considered on the downstream end of the culvert to reduce the length of the culvert. For a pre-cast concrete culvert, the extent to which separate walls will be cost effective is likely limited. If more extensive shoring, such as soldier piles and lagging walls, are used, permanent cantilever soldier piles could be used. The length of the section where cantilever piles would be used to form an open channel will depend on the maximum steel section that the design team would like to use for the project. In our experience, the maximum height for which cantilever soldier pile walls are cost-effective is about 12 feet of retained height.

SEISMIC DESIGN

Permanent structures at the site will need to be designed to resist the forces imposed on the structure during a seismic event. This will include providing stable slopes during a seismic event for the toe walls and withstanding catastrophic failure of the culvert structure. We anticipate that design for the proposed structures will not be limited by the seismic design requirements. We do not anticipate having to design for the effects of liquefaction as there is only a thin zone of saturated material at the contact between the alluvium and the glaciolacustrine deposits.

CONSTRUCTABILITY CONSIDERATIONS

Utility Protection

Protection of the existing 8-inch sewer line that crosses the site within the roadway embankment will be required. This may require supporting the existing line within the excavation, installing a bypass line to be used for the duration of construction. Feasibility of protecting the existing line without damaging it will depend on the type of pipe and its current integrity. If there is concern that pipe segments could separate if disturbed, it may be advantageous to install a temporary section of pipe, such as HDPE or ductile iron, for conveying the sewer across the project. This line would still need to be supported across the excavation; however, a new, temporary pipe section is less likely to be damaged during construction when compared with the existing line.

Subgrade Protection and Preparation

Hard glaciolacustrine soil is expected to be exposed at the subgrade elevation along most of the proposed culvert alignment. This material will be become soft and unsuitable to support foundations if it is disturbed while wet. We recommend protecting approved subgrades with a layer of crushed rock to provide a working surface and a leveling pad for the culvert.

Reuse of Materials

The granular portions of the existing fill and alluvium observed in our borings may be reused as roadway embankment fill; however, these materials contain a significant amount of silt and will be moisture sensitive. Reuse will likely be suitable only if the construction is performed during the dry summer months and the contractor selectively excavates and stores the granular excavation spoils. The hard glaciolacustrine and clayey and silty colluvium and slide deposits are not suitable for reuse.

CONDITIONS AND LIMITATIONS

We have prepared this report for Herrera Environmental Consultants, Inc. and the City of Shoreline for use for use in preliminary evaluation of this site for the intended purpose. This report is not a detailed geotechnical engineering design report; and geotechnical engineering evaluations were not conducted as part of this work.

Our work scope did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or ground water at this site.

Experience has shown that soil and ground water conditions can vary significantly over small distances. Inconsistent conditions can occur between exploration locations and may not be detected by a preliminary geotechnical evaluation of this nature. If, during future site operations, subsurface conditions are encountered which vary appreciably from those described herein, HWA should be notified for review of the recommendations of this report, and revision of such if necessary.

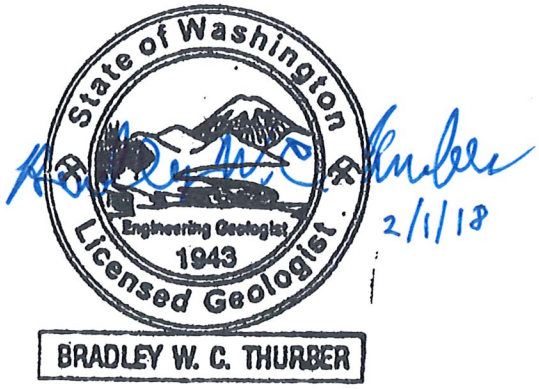
Within the limitations of scope, schedule and budget, HWA attempted to execute these services in accordance with generally accepted professional principles and practices in the fields of geotechnical engineering and engineering geology in the area at the time the report was prepared. No warranty, express or implied, is made.

February 1, 2018
HWA Project No. 2017-096-21

We appreciate the opportunity to be of service. Should you have any questions regarding this report, or require additional services, please contact us.

Sincerely,

HWA GEOSCIENCES INC.



Brad W. Thurber, L.G., L.E.G.
Senior Engineering Geologist

JoLyn Gillie, P.E.
Geotechnical Engineer, Principal

Attachments:

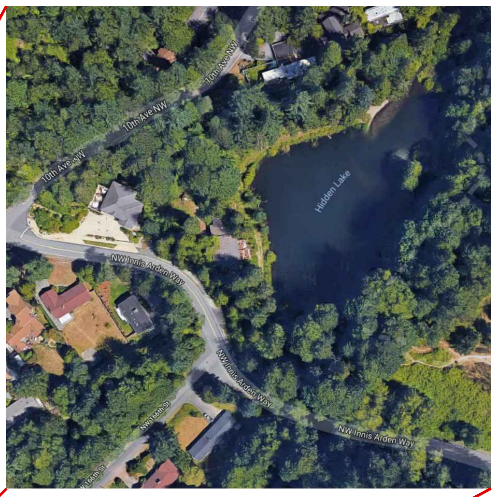
Figure 1	Vicinity Map
Figure 2	Site and Exploration Plan
Figure 3	Cross Section A-A'
Figure 4	Cross Section B-B'
Appendix A	Borehole Logs
Appendix B	Laboratory Data

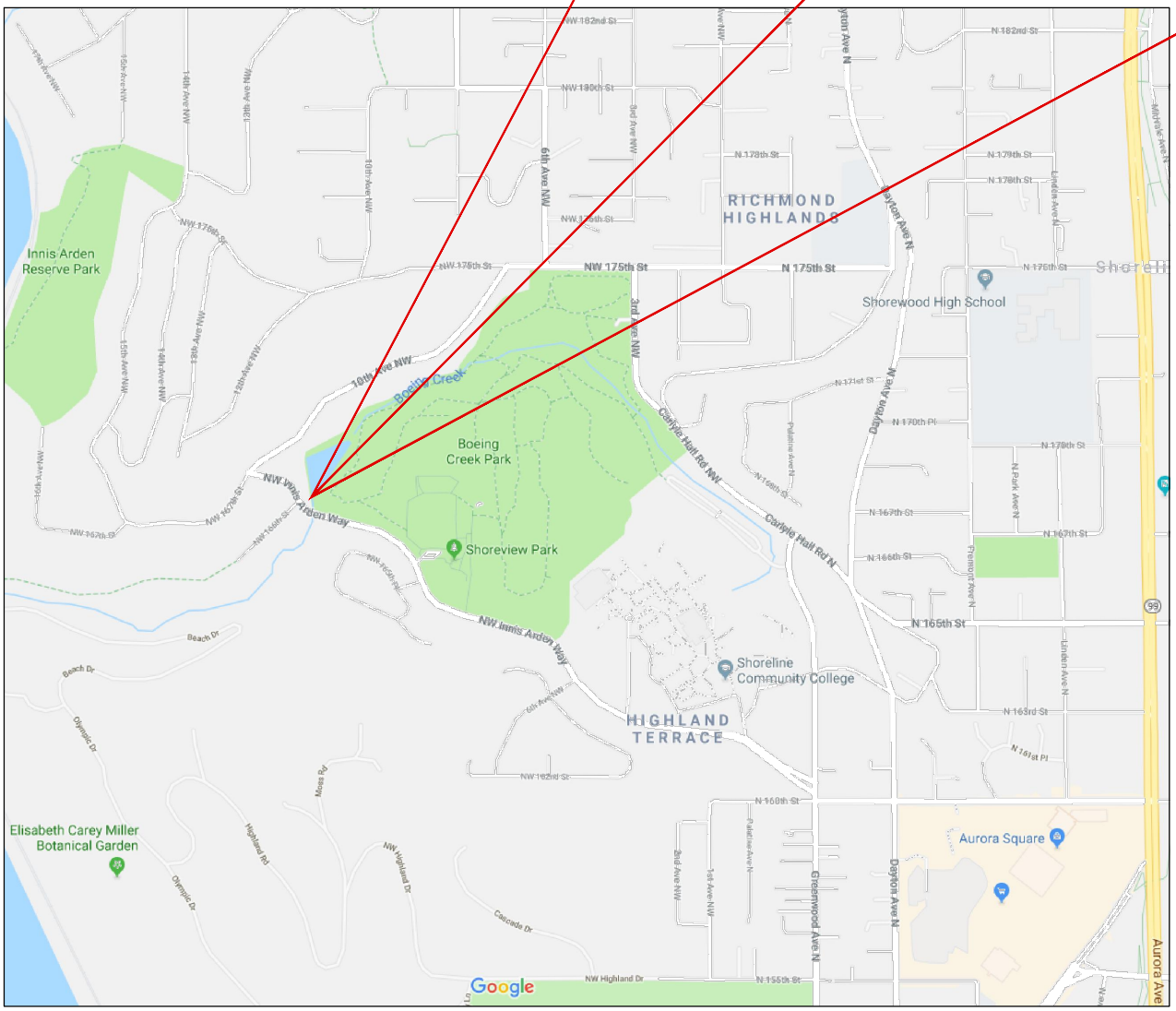
REFERENCES:

Minard, J.P., 1983, *Geologic Map of the Edmonds East and part of the Edmonds West Quadrangles, Washington:* USGS Miscellaneous Field Studies Map MF-1541.

Perrone Consulting Inc., October 2015, *Hidden Lake Dam Removal*: Project No. 15126 for Herrera Consultants.

Shannon & Wilson Inc., September 1995, *Geotechnical Engineering Report, Hidden Lake Restoration Project, King County, Washington:* Project No. W-7022-03 for R.W. Beck.





BASE MAP PROVIDED BY: GOOGLE MAPS

HWA GeoSciences Inc.

VICINITY MAP

HIDDEN LAKE DAM
SHORELINE, WA.

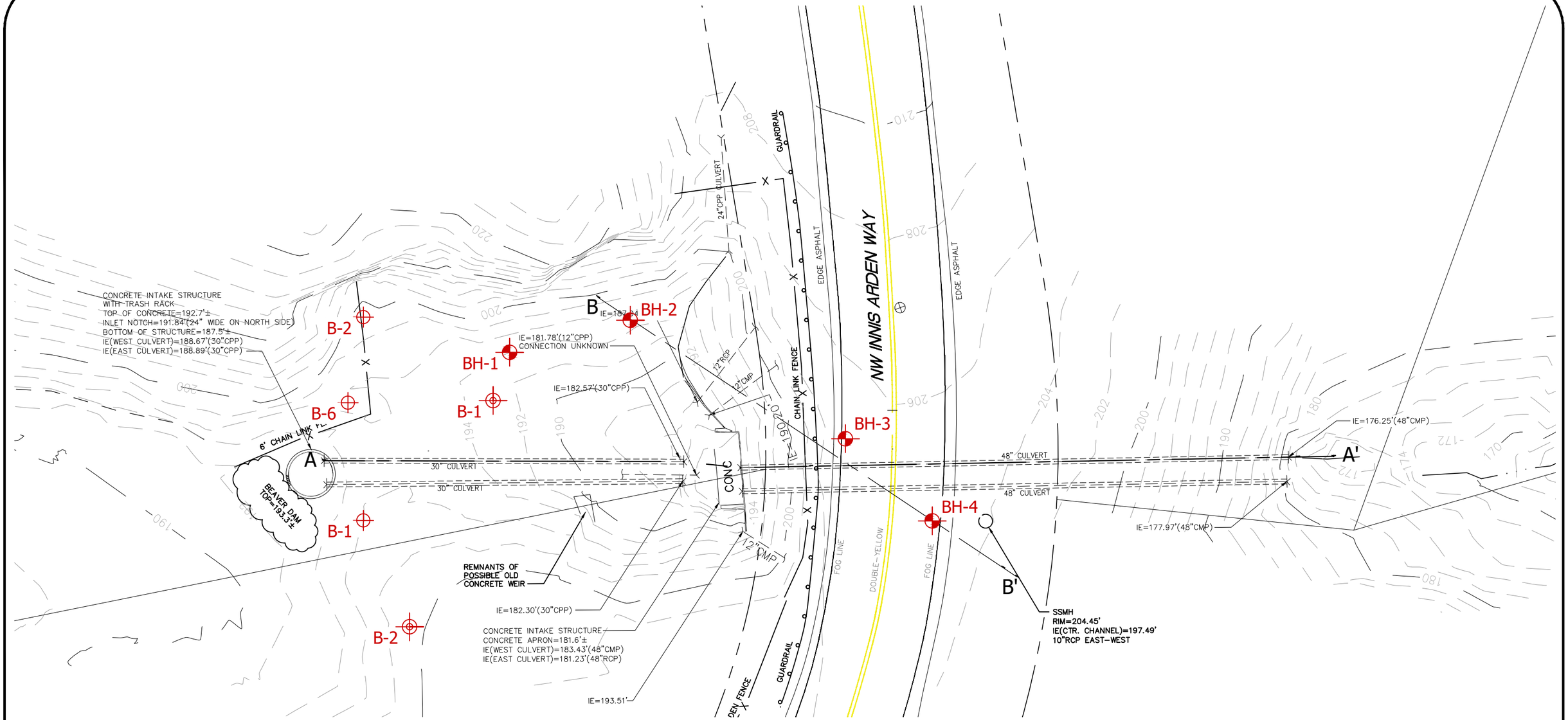
CHECK BY	DRAWN BY
JG	BFM

DATE: 12.04.2017

FIGURE # 1

PROJECT # 2017-096-21

S:\2017 PROJECTS\2017-096-21 HIDDEN LAKE DAM REMOVAL PROJECT\CAD\2017-096-21 HIDDEN LAKE DAM.DWG <Fig 1> Plotted: 12/5/2017 3:30 PM



LEGEND

- BH-1 — BOREHOLE DESIGNATION AND APPROXIMATE LOCATION FOR CURRENT STUDY
- B-1 — BOREHOLE DESIGNATION AND APPROXIMATE LOCATION (PERRONE, 2015)
- B-2 — BOREHOLE DESIGNATION AND APPROXIMATE LOCATION (SHANNON AND WILSON, 1995)

BASE SURVEY PROVIDED BY: HERRERA, DATED 10.05.2015

0 10 20 30 40

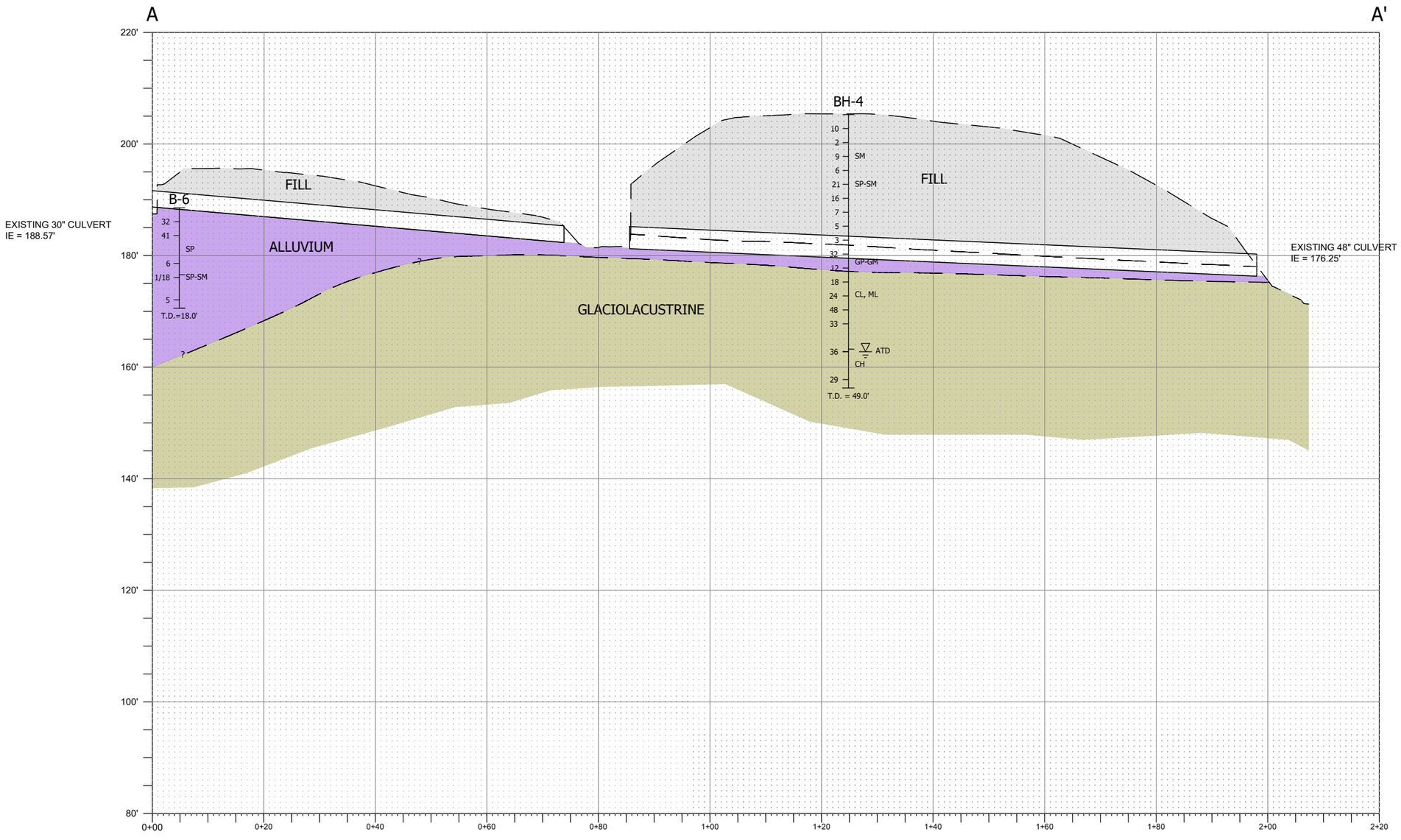
HWA GeoSciences Inc.

HIDDEN LAKE DAM REMOVAL AND STREAM RESTORATION PROJECT SHORELINE, WASHINGTON

SITE AND EXPLORATION PLAN

DRAWN BY	BFM
CHECK BY	BT
DATE:	01.05.2018
FIGURE #	2
PROJECT #	2017-096-21

S:\2017 PROJECTS\2017-096-21 HIDDEN LAKE DAM REMOVAL PROJECT\CAD\2017-096-21 HIDDEN LAKE DAM.DWG <Fig 2> Plotted: 1/10/2018 3:51 PM



LEGEND

BH-3 EXPLORATION DESIGNATION

8
20
28 SM USCS SOIL CLASS
30 BLOW COUNT "N-VALUE"

WATER LEVEL AT TIME OF EXPLORATION

INFERRED GEOLOGIC CONTACT

46.5 CL BOTTOM OF EXPLORATION

SOIL LEGEND

- FILL: LOOSE TO VERY DENSE SILTY SAND
- ALLUVIUM: LOOSE TO MEDIUM DENSE SAND AND GRAVEL
- GLACIOLACUSTRINE: VERY STIFF TO HARD SILT AND CLAY

The subsurface conditions shown are based on widely spaced borings and should be considered approximate. Further, the contact lines shown between units are interpretive in nature and may vary laterally or vertically over relatively short distances on site.

0 10 20 30 40

BASE SURVEY PROVIDED BY: HERRERA, DATED 10.05.2015

HWA GeoSciences Inc.

HIDDEN LAKE DAM REMOVAL AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

GEOLOGIC CROSS-SECTION A-A'

DRAWN BY	BFM
CHECK BY	BT
DATE:	01.05.2018
FIGURE #	3
PROJECT #	2017-096-21

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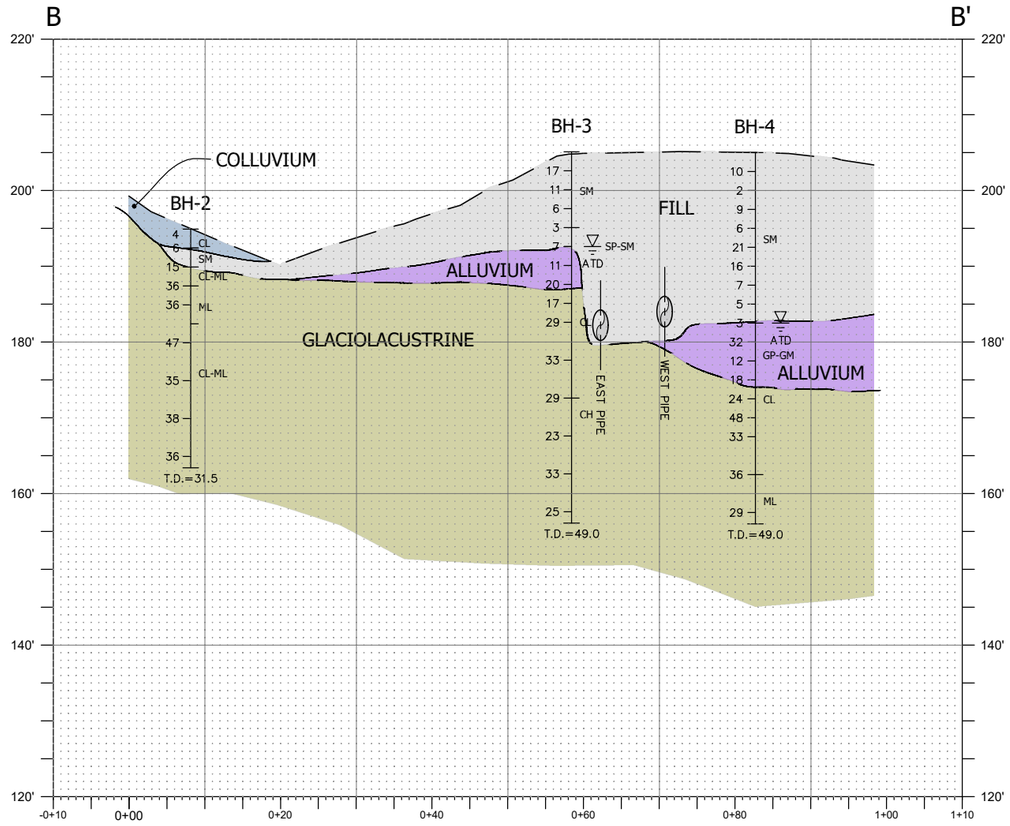
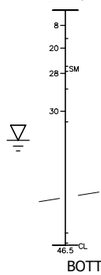


LEGEND

BH-3 EXPLORATION DESIGNATION



USCS SOIL CLASS

BLOW COUNT "N-VALUE "

WATER LEVEL AT TIME OF EXPLORATION

INFERRED GEOLOGIC CONTACT

BOTTOM OF EXPLORATION

SOIL LEGEND

- SOIL UNIT A - COLLUVIUM: SOFT CLAY WITH ORGANICS AND SCATTERED SAND
- SOIL UNIT B - FILL: LOOSE TO VERY DENSE SILTY SAND
- SOIL UNIT C - ALLUVIUM: LOOSE TO MEDIUM DENSE SAND AND GRAVEL
- SOIL UNIT D - SLIDE DEBRIS: SOFT TO MEDIUM STIFF, FAT CLAY AND SILTY CLAY WITH SLICKENSIDES
- SOIL UNIT E - GLACIOLACUSTRINE: VERY STIFF TO HARD SILT AND CLAY

BASE SURVEY PROVIDED BY: HERRERA, DATED 10.05.2015

The subsurface conditions shown are based on widely spaced borings and should be considered approximate. Further, the contact lines shown between units are interpretive in nature and may vary laterally or vertically over relatively short distances on site.

0 10 20 30 40

HWA GEOSCIENCES INC.

HIDDEN LAKE DAM REMOVAL AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

GEOLOGIC CROSS-SECTION B-B'

DRAWN BY	BFM
CHECK BY	BT
DATE:	01.09.2018
FIGURE #	4
PROJECT #	2017-096-21

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APPENDIX A

BOREHOLE LOGS

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE

COHESIONLESS SOILS			COHESIVE SOILS		
Density	N (blows/ft)	Approximate Relative Density(%)	Consistency	N (blows/ft)	Approximate Undrained Shear Strength (psf)
Very Loose	0 to 4	0 - 15	Very Soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Medium Dense	10 to 30	35 - 65	Medium Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

USCS SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP DESCRIPTIONS	
Coarse Grained Soils	Gravel and Gravelly Soils	Clean Gravel (little or no fines)	GW	Well-graded GRAVEL
			GP	Poorly-graded GRAVEL
	More than 50% of Coarse Fraction Retained on No. 4 Sieve	Gravel with Fines (appreciable amount of fines)	GM	Silty GRAVEL
			GC	Clayey GRAVEL
More than 50% Retained on No. 200 Sieve Size	Sand and Sandy Soils	Clean Sand (little or no fines)	SW	Well-graded SAND
			SP	Poorly-graded SAND
	50% or More of Coarse Fraction Passing No. 4 Sieve	Sand with Fines (appreciable amount of fines)	SM	Silty SAND
			SC	Clayey SAND
Fine Grained Soils	Silt and Clay	Liquid Limit Less than 50%	ML	SILT
			CL	Lean CLAY
			OL	Organic SILT/Organic CLAY
50% or More Passing No. 200 Sieve Size	Silt and Clay	Liquid Limit 50% or More	MH	Elastic SILT
			CH	Fat CLAY
			OH	Organic SILT/Organic CLAY
Highly Organic Soils			PT	PEAT

TEST SYMBOLS

%F	Percent Fines
AL	Atterberg Limits: PL = Plastic Limit, LL = Liquid Limit
CBR	California Bearing Ratio
CN	Consolidation
DD	Dry Density (pcf)
DS	Direct Shear
GS	Grain Size Distribution
K	Permeability
MD	Moisture/Density Relationship (Proctor)
MR	Resilient Modulus
PID	Photoionization Device Reading
PP	Pocket Penetrometer Approx. Compressive Strength (tsf)
SG	Specific Gravity
TC	Triaxial Compression
TV	Torvane Approx. Shear Strength (tsf)
UC	Unconfined Compression

SAMPLE TYPE SYMBOLS

- 2.0" OD Split Spoon (SPT) (140 lb. hammer with 30 in. drop)
- Shelby Tube
- 3-1/4" OD Split Spoon with Brass Rings
- Small Bag Sample
- Large Bag (Bulk) Sample
- Core Run
- Non-standard Penetration Test (3.0" OD split spoon)

GROUNDWATER SYMBOLS

- Groundwater Level (measured at time of drilling)
- Groundwater Level (measured in well or open hole after water level stabilized)

COMPONENT DEFINITIONS

COMPONENT	SIZE RANGE
Boulders	Larger than 12 in
Cobbles	3 in to 12 in
Gravel	3 in to No 4 (4.5mm)
Coarse gravel	3 in to 3/4 in
Fine gravel	3/4 in to No 4 (4.5mm)
Sand	No. 4 (4.5 mm) to No. 200 (0.074 mm)
Coarse sand	No. 4 (4.5 mm) to No. 10 (2.0 mm)
Medium sand	No. 10 (2.0 mm) to No. 40 (0.42 mm)
Fine sand	No. 40 (0.42 mm) to No. 200 (0.074 mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

COMPONENT PROPORTIONS

PROPORTION RANGE	DESCRIPTIVE TERMS
< 5%	Clean
5 - 12%	Slightly (Clayey, Silty, Sandy)
12 - 30%	Clayey, Silty, Sandy, Gravelly
30 - 50%	Very (Clayey, Silty, Sandy, Gravelly)
Components are arranged in order of increasing quantities.	

NOTES: Soil classifications presented on exploration logs are based on visual and laboratory observation.
Soil descriptions are presented in the following general order:

Density/consistency, color, modifier (if any) GROUP NAME, additions to group name (if any), moisture content. Proportion, gradation, and angularity of constituents, additional comments. (GEOLOGIC INTERPRETATION)

Please refer to the discussion in the report text as well as the exploration logs for a more complete description of subsurface conditions.

MOISTURE CONTENT

DRY	Absence of moisture, dusty, dry to the touch.
MOIST	Damp but no visible water.
WET	Visible free water, usually soil is below water table.

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SHORELINE, WASHINGTON

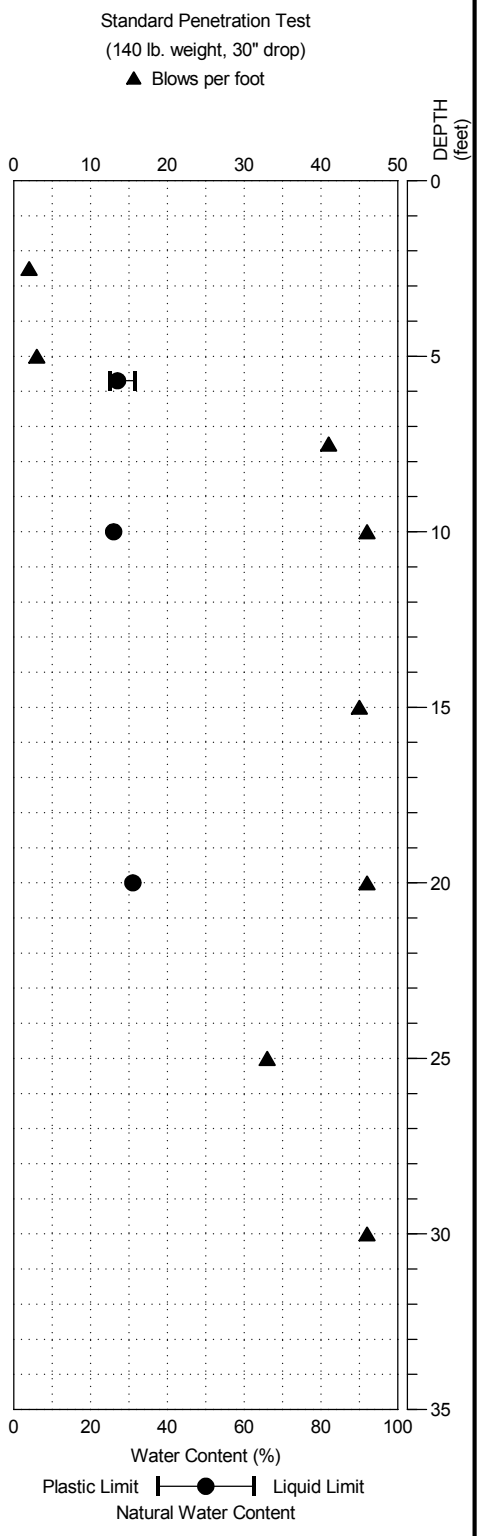
LEGEND OF TERMS AND SYMBOLS USED ON EXPLORATION LOGS

PROJECT NO.: 2017-096-21 FIGURE: A-1

DRILLING COMPANY: Geologic Drill, Inc.
DRILLING METHOD: HSA, Bobcat minitrack
SAMPLING METHOD: SPT w/ cathead
SURFACE ELEVATION: 194.00 ± feet

LOCATION: See Figure 2
DATE STARTED: 10/31/2017
DATE COMPLETED: 10/31/2017
LOGGED BY: B. Thurber/ S. Khandaker

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
0		ML SM	Loose, dark brown, sandy SILT. **(COLLUVIUM)**					
			Very loose, reddish, ORGANIC SILT, moist. Rotten wood with topsoil.		S-1	3-1-1		
5		GP GM	Very loose, olive brown, slightly silty, slightly sandy, fine GRAVEL, wet. **(FILL)**		S-2a S-2b	1-1-2	AL	
		ML	Soft, gray, SILT, moist. Low plasticity, blocky texture to massive. **(COLLUVIUM)**					
		ML	Hard, gray, SILT, moist. Low plasticity, some bedding; mostly massive. **(GLACIOLACUSTRINE)**		S-3	19-19-22		
10			Hard, gray, SILT, moist. Low plasticity, some bedding; mostly massive, crumbly texture.		S-4	10-16-30		
15			Hard, gray, SILT, moist. Low plasticity. Laminated and finely bedded. Coarse, light gray. silt partings. Crumbly texture.		S-5	12-15-20		
20		CL ML	Hard, gray, silty CLAY, moist. Laminated to finely bedded. Light gray, non plastic, silt partings.		S-6	12-20-26		
25		SM	Dense, gray, silty, fine SAND, moist.		S-7a S-7b	12-12-21		
		CL ML	Hard, gray to dark gray, silty CLAY, moist. Some bedding, mostly massive. Crumbly texture at transition from sand.					
30			Hard, gray, silty CLAY, moist. Laminated, interbedded with, dense, gray, non-plastic silt, wet.		S-8a S-8b	18-16-30		
35			Borehole terminated at 31.5 feet. Minor ground water seepage encountered at 30 feet. Borehole abandoned with bentonite chips.					



For a proper understanding of the nature of subsurface conditions, this exploration log should be read in conjunction with the text of the geotechnical report.

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

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HIDDEN LAKE DAM REMOVAL
AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

BORING:
BH-1

PAGE: 1 of 1

PROJECT NO.: 2017-096-21 FIGURE: A-2

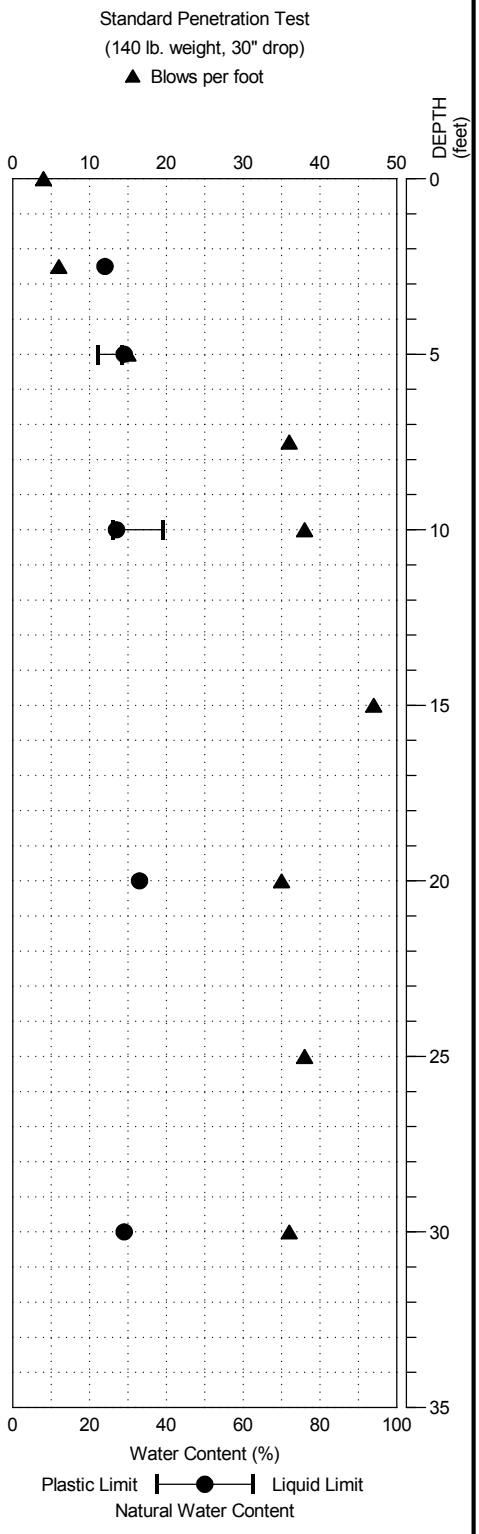
BORING 2017-096-21.GPJ 1/8/18

DRILLING COMPANY: Geologic Drill, Inc.
DRILLING METHOD: HSA, Bobcat minitrack
SAMPLING METHOD: SPT w/ cathead
SURFACE ELEVATION: 195.00 ± feet

LOCATION: See Figure 2
DATE STARTED: 10/31/2017
DATE COMPLETED: 10/31/2017
LOGGED BY: B. Thurber/ S. Khandaker

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0		CL	Soft, light brown, CLAY, moist. Scattered organics.		S-1	1-2-2	
			(COLLUVIUM)				
		SM	Loose, brown and gray, silty, fine to coarse SAND, wet. Trace gravel.		S-2	2-4-2	GS
5			**(ALLUVIUM)**				
		CL ML	Stiff, gray, silty CLAY, moist to wet. Scattered organics.		S-3	5-6-9	AL
			(COLLUVIUM)				
		ML	Hard, gray, SILT, moist. Laminated with gray silt partings. Crumbly texture.		S-4	10-16-20	
10			**(GLACIOLACUSTRINE)** Hard, gray, SILT, moist. Blocky, disturbed texture.		S-5	10-16-22	AL
		CL ML					
15			Hard, gray and light gray, silty CLAY, moist. Laminated and finely bedded with zones of blocky texture.		S-6	13-18-29	
20			Hard, gray, silty CLAY, moist. Laminated to massive.		S-7	15-15-20	
25			Hard, gray, silty CLAY, moist. Finely bedded, some lamination with zones of blocky texture.		S-8	12-15-23	
30			Hard, gray, silty CLAY, moist. Laminated. Some fine sandy silt at top. Crumbly texture at sandy silt contact.		S-9	10-16-20	
35			Borehole terminated at 31.5 feet. Ground water seepage encountered at 5 feet. Borehole abandoned with bentonite chips.				

GROUNDWATER



For a proper understanding of the nature of subsurface conditions, this exploration log should be read in conjunction with the text of the geotechnical report.

NOTE: This log of subsurface conditions applies only at the specified location and on the date indicated and therefore may not necessarily be indicative of other times and/or locations.

HWA GEOSCIENCES INC.

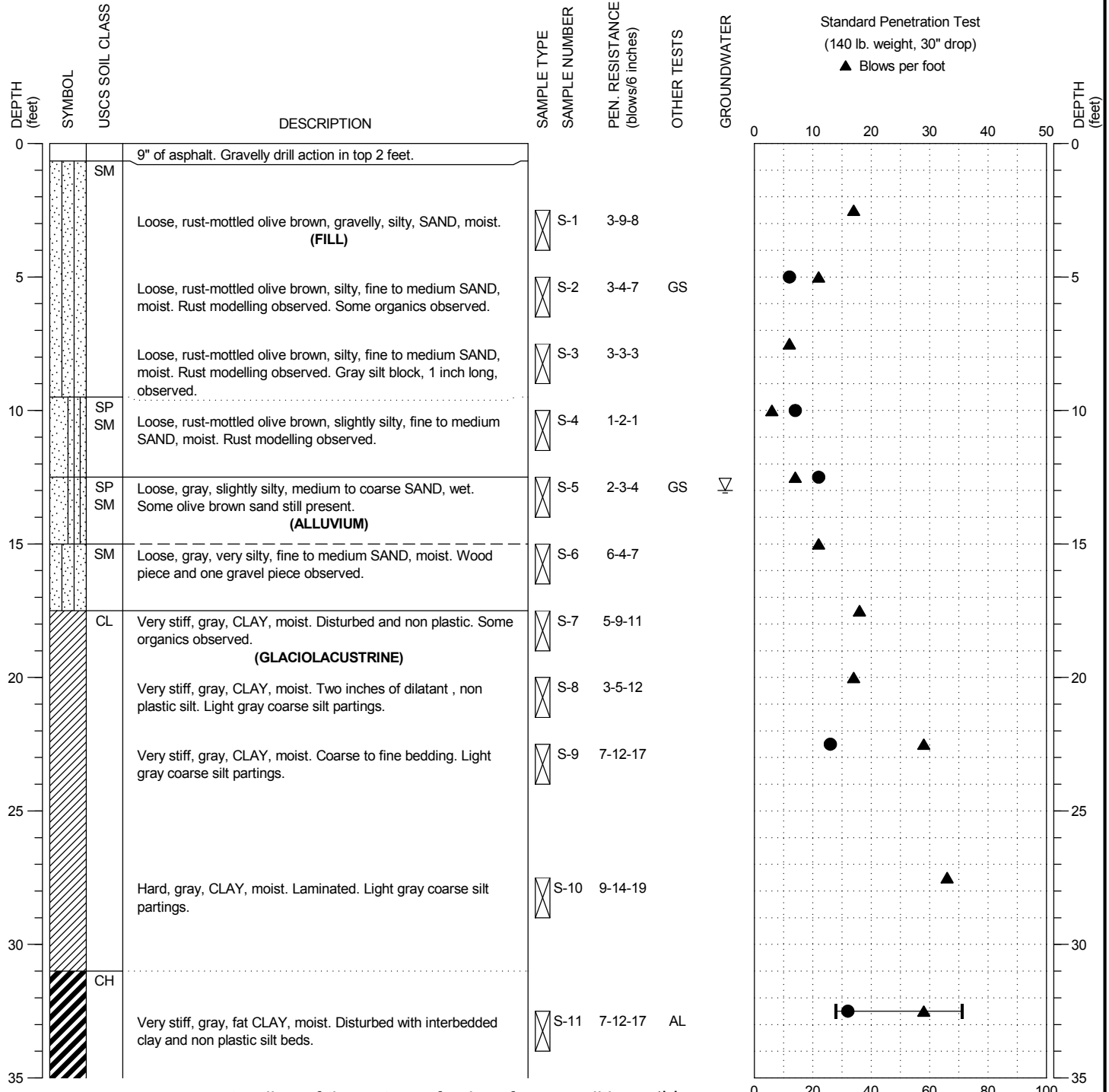
HIDDEN LAKE DAM REMOVAL
AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

BORING:
BH-2

PROJECT NO.: 2017-096-21 FIGURE: A-3

DRILLING COMPANY: Environmental Drilling Inc.
DRILLING METHOD: HSA, Mobile B-61
SAMPLING METHOD: SPT w/ autohammer
SURFACE ELEVATION: 205.00 ± feet

LOCATION: See Figure 2
DATE STARTED: 11/9/2017
DATE COMPLETED: 11/9/2017
LOGGED BY: S. Khandaker/B. Thurber



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HWA GEOSCIENCES INC.

HIDDEN LAKE DAM REMOVAL
AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

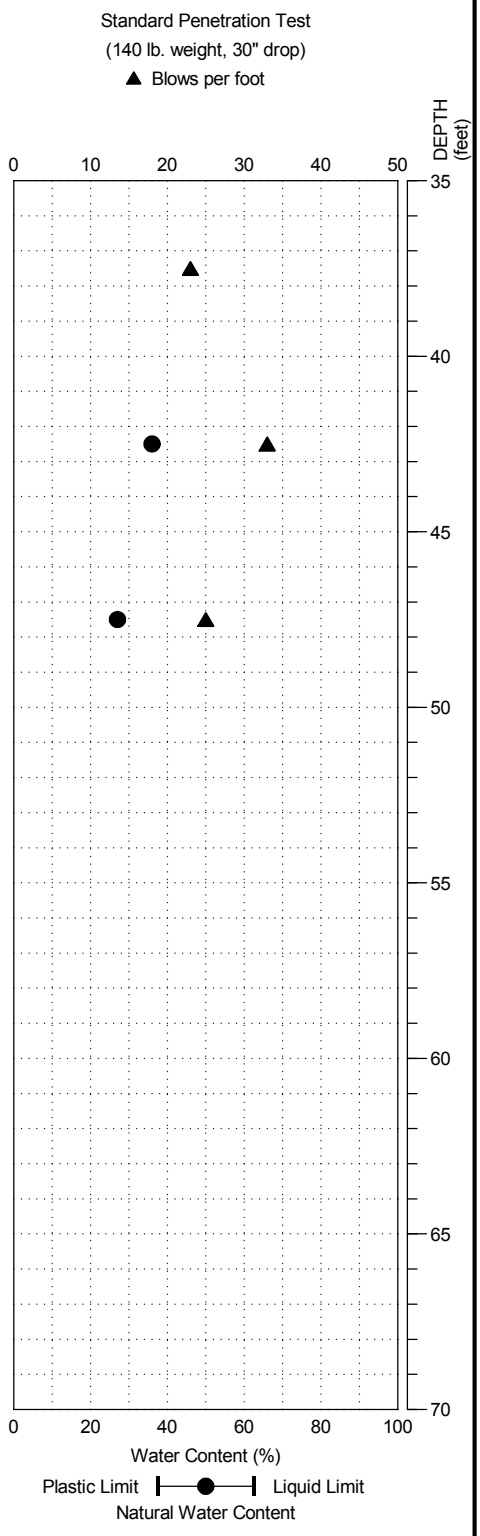
BORING:
BH-3

PROJECT NO.: 2017-096-21 FIGURE: A-4

DRILLING COMPANY: Environmental Drilling Inc.
DRILLING METHOD: HSA, Mobile B-61
SAMPLING METHOD: SPT w/ autohammer
SURFACE ELEVATION: 205.00 ± feet

LOCATION: See Figure 2
DATE STARTED: 11/9/2017
DATE COMPLETED: 11/9/2017
LOGGED BY: S. Khandaker/B. Thurber

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
35			Very stiff, gray, fat CLAY, moist. Laminated. Variable drilling resistance, with slickensides.		S-12	6-9-14		
40			Hard, gray, fat CLAY, moist, with slickensides.		S-13	7-15-18		
45		SP	Very stiff, gray, fat CLAY, moist.		S-14a	7-8-17	GS	
		SM	Medium dense, brown, slightly silty, fine SAND, wet.		S-14b			
50			Borehole terminated at 49 feet. Ground water seepage encountered at 13 and 36 feet. Borehole abandoned with bentonite chips.					
55								
60								
65								
70								



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HWA GEOSCIENCES INC.

HIDDEN LAKE DAM REMOVAL
AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

BORING:
BH-3

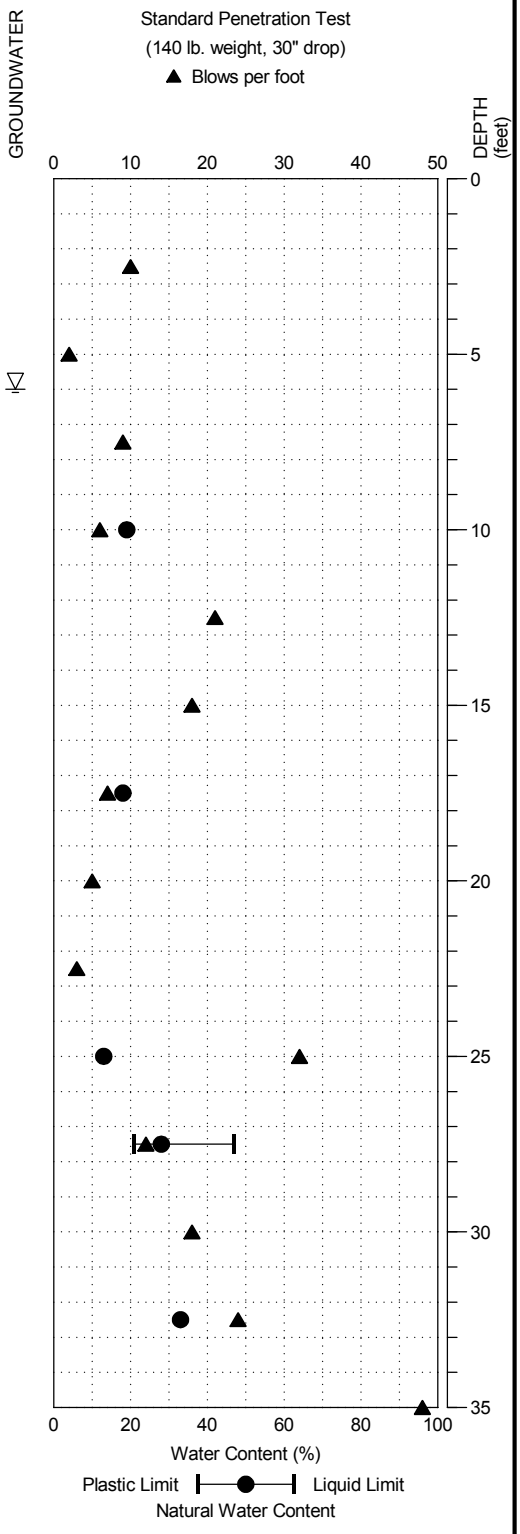
PROJECT NO.: 2017-096-21 FIGURE: A-4

DRILLING COMPANY: Environmental Drilling Inc.
DRILLING METHOD: HSA, Mobile B-61
SAMPLING METHOD: SPT w/ autohammer
SURFACE ELEVATION: 205.00 ± feet

LOCATION: See Figure 2
DATE STARTED: 11/9/2017
DATE COMPLETED: 11/9/2017
LOGGED BY: S. Khandaker

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS
0			9.5" of asphalt.				
		SM	Loose, brown, silty to very silty, fine to medium SAND, moist.		S-1a	7-5-5	
		ML	Loose, gray, sandy, SILT, moist. Trace organics. Plastic.		S-1b		
			(FILL)				
5		SM	Loose, olive brown, silty to very silty, fine to medium SAND, moist.		S-2	2-1-1	
			Loose, gray, slightly gravelly, silty, fine to medium SAND, moist, with silt clumps.		S-3	6-5-4	
10			Loose, gray, silty, fine to medium SAND, moist. Dark brown organics observed.		S-4	3-3-3	GS
			Dense, gray, silty, fine to medium SAND, moist, with silt clumps.		S-5	5-10-11	
15			Dense, gray to dark brown, silty, fine to medium SAND, moist, with silt clumps.		S-6	5-7-9	
			Loose, gray, silty, fine to medium SAND, moist. Greenish gray clay piece and wood pieces observed.		S-7	1-3-4	
20			Loose, gray, silty, fine to medium SAND, moist. Decomposed wood at top.		S-8	3-3-2	
			Loose, very dark brown, silty, fine to medium SAND, moist. Organics observed.		S-9	1-1-2	
		GP GM	**(BURIED TOPSOIL)**				
25			Loose, gray, slightly silty, sandy, fine to medium GRAVEL, wet. With dark brown organics pockets. Sampler drove on a rock.		S-10	11-16-16	GS
			(ALLUVIUM)				
		CL	Stiff, gray, CLAY, moist. Low recovery.		S-11	3-5-7	AL
30			Wood.		S-12	21-9-9	
		CL	Very stiff, gray, CLAY, moist. Transition from disturbed to laminated. Wood at the top of the sample.		S-13	7-10-14	
35							

GROUNDWATER ▽



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HWA GEOSCIENCES INC.

HIDDEN LAKE DAM REMOVAL
AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

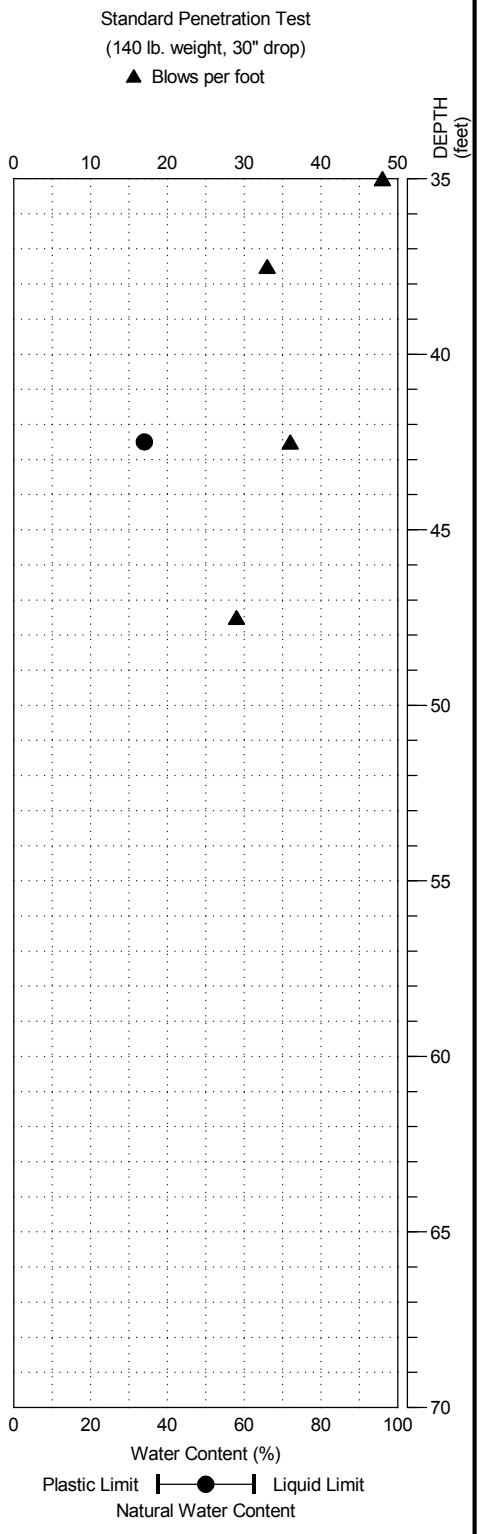
BORING:
BH-4

PROJECT NO.: 2017-096-21 FIGURE: A-5

DRILLING COMPANY: Environmental Drilling Inc.
DRILLING METHOD: HSA, Mobile B-61
SAMPLING METHOD: SPT w/ autohammer
SURFACE ELEVATION: 205.00 ± feet

LOCATION: See Figure 2
DATE STARTED: 11/9/2017
DATE COMPLETED: 11/9/2017
LOGGED BY: S. Khandaker

DEPTH (feet)	SYMBOL	USCS SOIL CLASS	DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	PEN. RESISTANCE (blows/6 inches)	OTHER TESTS	GROUNDWATER
35		ML	Hard, gray, coarse SILT, moist. Non plastic.		S-14	9-17-31		
		CH	Hard, gray, CLAY, moist. Finely bedded/ laminated. Light gray, coarse silt partings, with slickensides.		S-15	11-12-21		
40			Hard, gray, CLAY, moist. Laminated with light gray silt partings, with slickensides.		S-16	7-12-24		
45		SM	Dense, gray, silty, fine SAND, wet.		S-17	7-11-18		
50			Borehole terminated at 49 feet. Ground water seepage encountered at 6 and 43 feet. Borehole abandoned with bentonite chips.					
55								
60								
65								
70								



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HWA GEOSCIENCES INC.

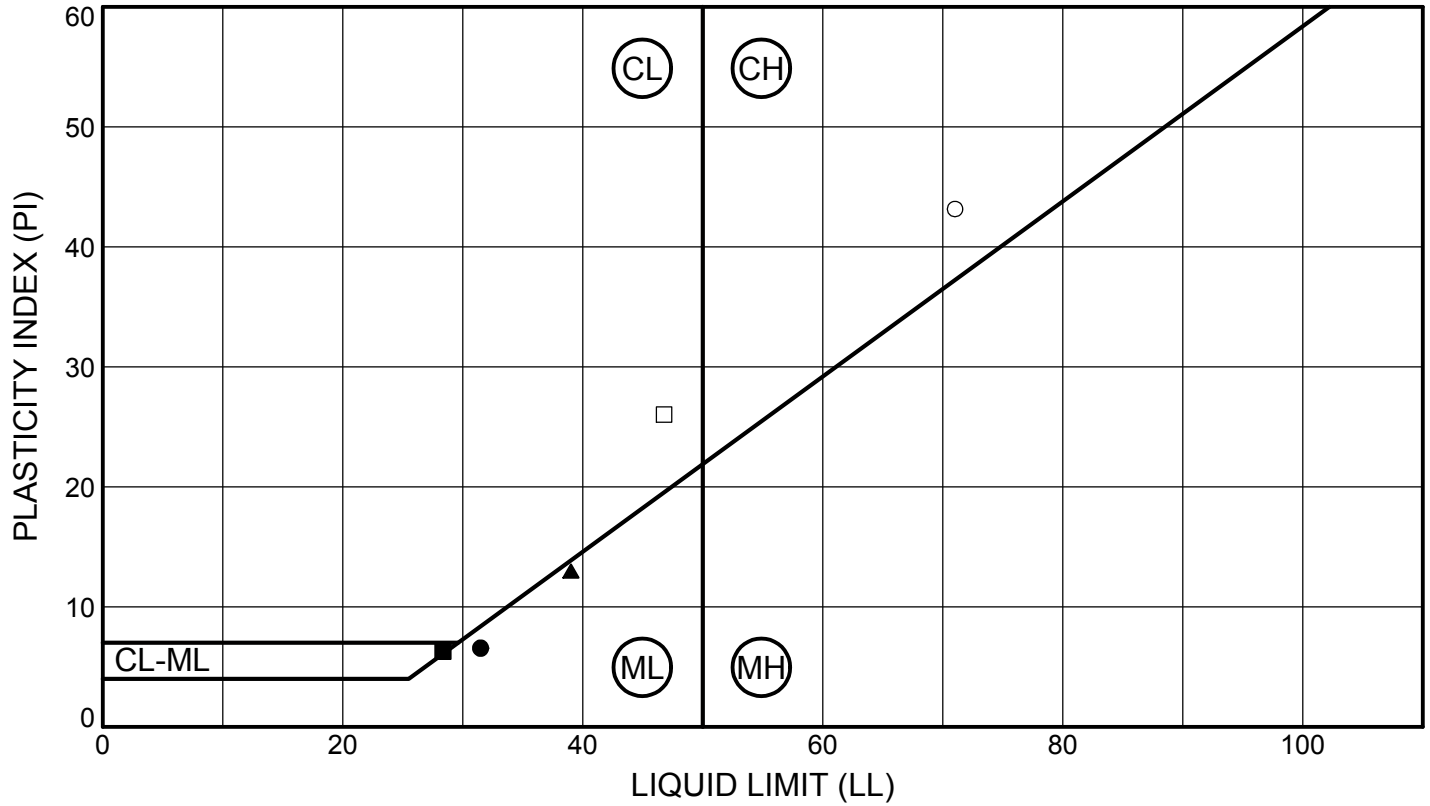
HIDDEN LAKE DAM REMOVAL
AND STREAM RESTORATION PROJECT
SHORELINE, WASHINGTON

BORING:
BH-4

PROJECT NO.: 2017-096-21 FIGURE: A-5

APPENDIX B

LABORATORY DATA



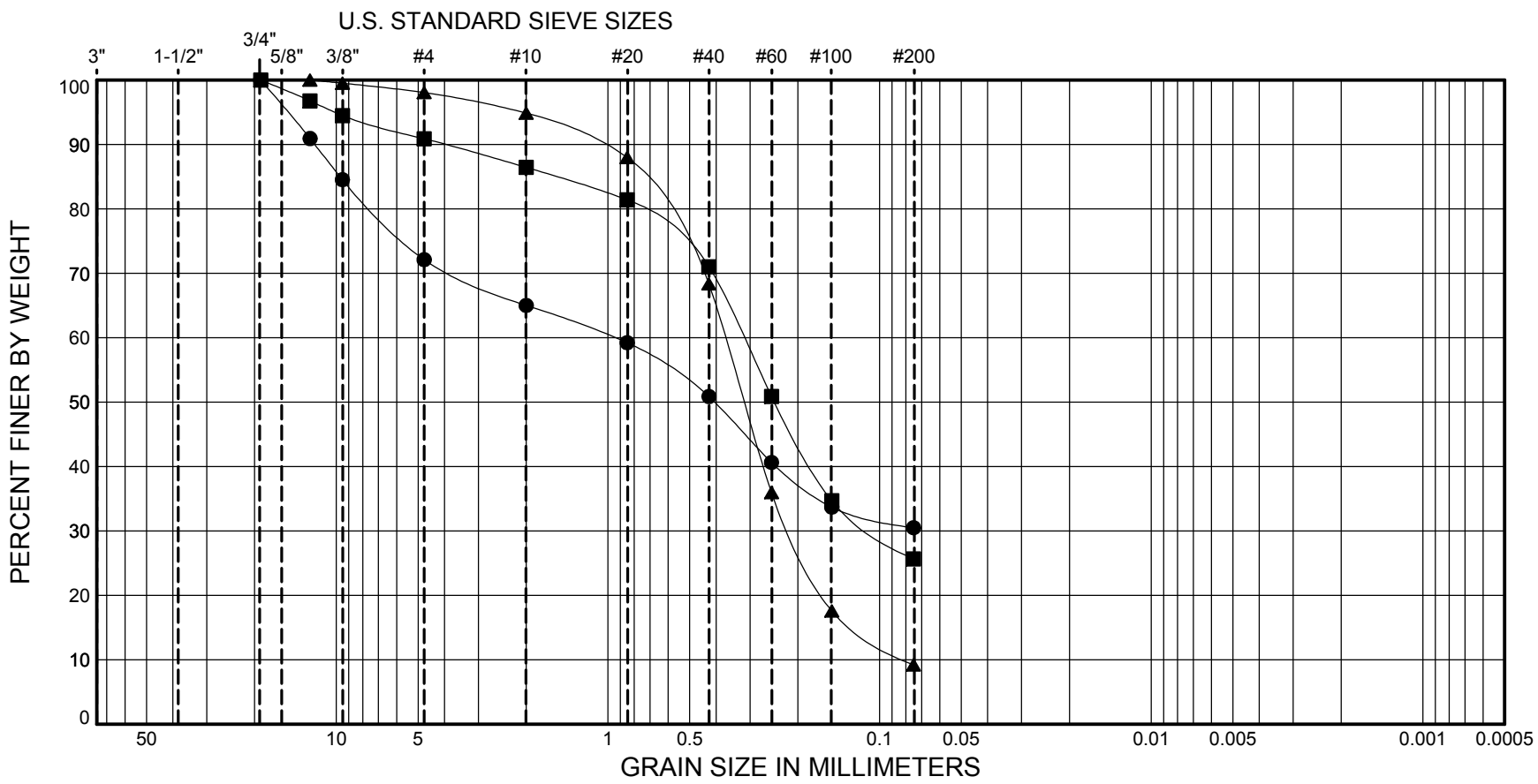
SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION	% MC	LL	PL	PI	% Fines
●	BH-1	S-2b	5.7 - 6.5	(ML) Dark gray, SILT	27	31	25	6	
■	BH-2	S-3	5.0 - 5.7	(CL-ML) Dark olive-gray, silty CLAY	29	28	22	6	
▲	BH-2	S-5	10.0 - 11.5	(ML) Dark gray, SILT	27	39	26	13	
○	BH-3	S-11	32.5 - 34.0	(CH) Dark gray, fat CLAY	32	71	28	43	
□	BH-4	S-11	27.5 - 27.7	(CL) Dark gray, lean CLAY	28	47	21	26	

HWA GEOSCIENCES INC.

Hidden Lake Dam Removal
Shoreline, WA

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS
METHOD ASTM D4318

PROJECT NO.: 2017-096-21 FIGURE: B-1



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-2	S-2	2.5 - 3.2	(SM) Grayish-brown, silty SAND with gravel	24				27.9	41.6	30.5
■	BH-3	S-2	5.0 - 6.0	(SM) Olive brown, silty SAND	12				9.1	65.2	25.7
▲	BH-3	S-5	12.5 - 13.2	(SP-SM) Grayish brown, poorly graded SAND with silt	22				2.0	88.8	9.2

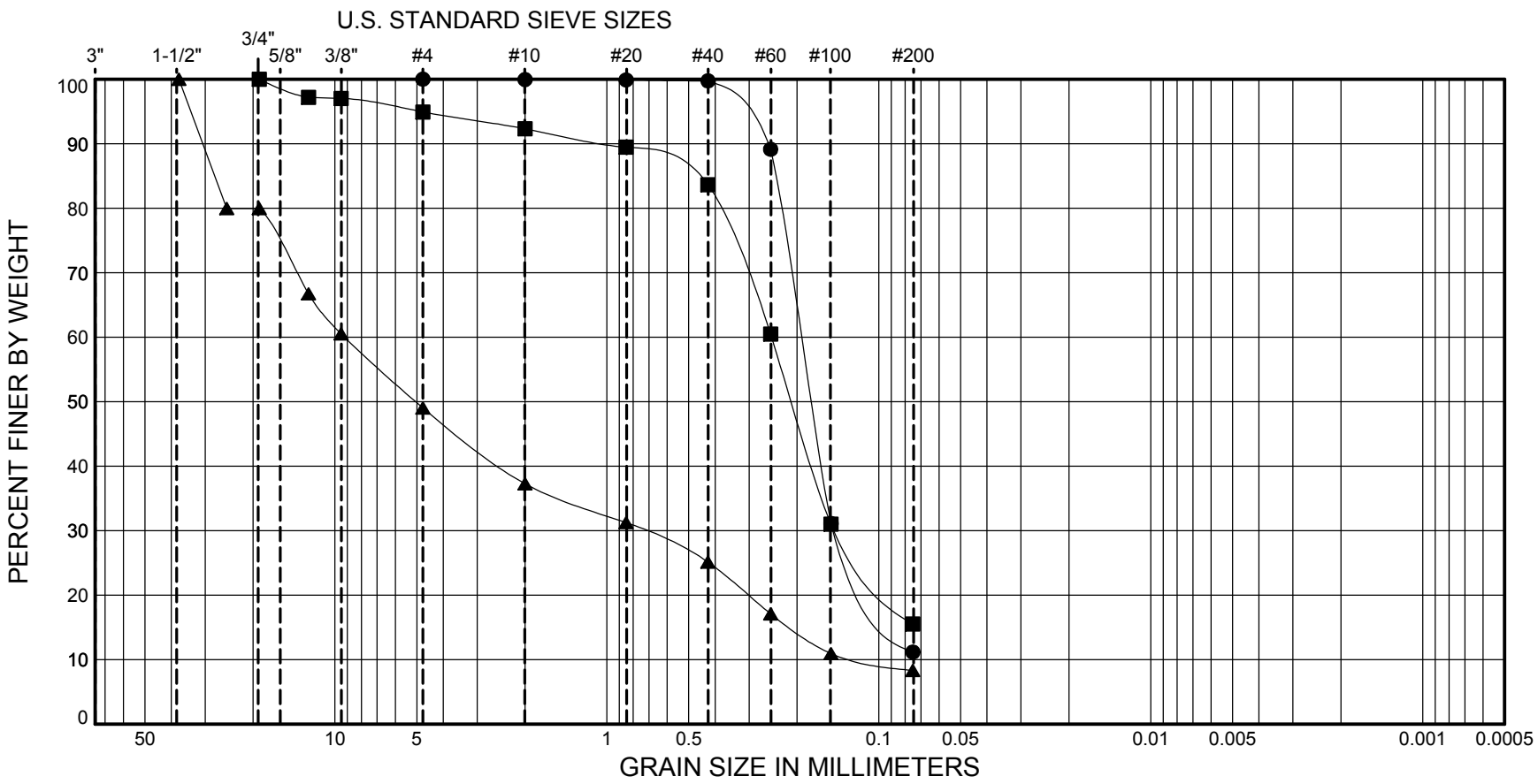
HWA GeoSciences Inc.

Hidden Lake Dam Removal
Shoreline, WA

PARTICLE-SIZE ANALYSIS
OF SOILS
METHOD ASTM D422

PROJECT NO.: 2017-096-21 FIGURE: B-2

GRAVEL		SAND			SILT	CLAY
Coarse	Fine	Coarse	Medium	Fine		



SYMBOL	SAMPLE		DEPTH (ft)	CLASSIFICATION OF SOIL- ASTM D2487 Group Symbol and Name	% MC	LL	PL	PI	Gravel %	Sand %	Fines %
●	BH-3	S-14a	47.5 - 47.7	(SP-SM) Grayish brown, poorly graded SAND with silt	27					88.8	11.2
■	BH-4	S-4	10.0 - 10.8	(SM) Grayish brown, silty SAND	19				5.1	79.4	15.5
▲	BH-4	S-10	25.0 - 25.3	(GP-GM) Grayish brown, poorly graded GRAVEL with silt and sand	13				51.0	40.7	8.3

HWA GeoSciences Inc.

Hidden Lake Dam Removal
Shoreline, WA

PARTICLE-SIZE ANALYSIS
OF SOILS
METHOD ASTM D422

PROJECT NO.: 2017-096-21 FIGURE: B-3

APPENDIX C

Preliminary Cost Estimates

Engineering Cost Estimate for Preliminary Design - Preferred Alternative "Lake Reach" OPTION A

(Phase division at STA 2+40, downstream of existing dam)

Project: **Hidden Lake Dam Removal**
Herrera **15-05984-000**
Client: **City of Shoreline**

Date Modified: 1/9/2018
Spreadsheet by: V. Wu
Checked by: I. Mostrenko
Latest Date Checked: 1/22/2018

Bid Item #	Spec Section	Item Description	Quantity	Unit	Unit Cost	Price	Total Price	Comments
		Mobilization	**1**	**LS**	**$ 55,900.00**		**$ 55,900.00**	8% of construction subtotal (Div 2 - Div 8 work items)
		Temporary Erosion and Sediment Control	**1**	**LS**	**$ 13,100.00**		**$ 13,100.00**	Assumes 2% of all other items except water management
		Water Management (Incl. Streamflow Bypass)	**1**	**LS**	**$ 30,000.00**		**$ 30,000.00**	based partly on bid cost for Coal Creek culvert replacement in Bellevue; cvers draining the lake and bulk bag bypass at the downstream end of the constructed stream channel
		Traffic Control	**1**	**LS**	**$ 10,000.00**		**$ 10,000.00**	rough estimate, needs City input; no road closure needed
		Stabilized Construction Entrance	**1**	**EA**	**$ 3,000.00**		**$ 3,000.00**	Price derived from WSDOT UBA. Entrance from Innis Arden Way toward the lake
		Site Clearing - Clearing and Grubbing and Stripping and Stockpiling of Topsoil	**0.64**	**AC**	**$ 14,300.00**		**$ 9,200.00**	Price from WSDOT UBA. Clearing for upstream channel construction, assume access is maintained from dam area if dam removed in previous year
		Bark or Wood Chip Mulch	**1.57**	**AC**	**$ 13,000.00**		**$ 20,500.00**	Trailside restoration areas (4" depth, 5' wide each side of trail); Includes temporary access routes (18ft x 3200ft x 0.25ft) and incidental amount for staging area preparation as well as removal as needed
		Removal of Dam Conveyance and Trash Rack	**1**	**LS**	**$ 2,000.00**		**$ 2,000.00**	Reuse onsite excavated material. Quantity from CAD. Embankment compaction for upstream channel bank where the channel is not naturally deep enough
		Remove and Dispose of Gabion Matresses on Dam Face	**1**	**LS**	**$ 2,000.00**		**$ 2,000.00**	
		Demolition of Lake Outlet Conveyance	**1**	**LS**	**$ 3,500.00**		**$ 3,500.00**	Manhole ~$1.5k, pull pipes $2k
		Channel Excavation	**4250**	**CY**	**$ 35.00**		**$ 148,800.00**	Quantity from "excavation quantites" tab Includes control of water, removal and stockpiling Assumes $33+$2 per cy for water management.
		Embankment Compaction	**60**	**CY**	**$ 6.00**		**$ 400.00**	Reuse onsite excavated material. Quantity from CAD. Embankment compaction for upstream channel bank where the channel is not naturally deep enough
		Stream Channel	**1**	**LS**	**$ 113,200.00**		**$ 113,200.00**	channel length=650+112 FT; width= 25 FT; 2%@ 500ft long and 3%@ 150ft long; includes cost for stream channel for both the 2% and 3% sections
		Import Boulders	214	CY	$ 100.00	$ 21,366.94		see Streambed Material tab; price from Manashtash project
		Import Streambed Cobble/ Gravel	1293	CY	$ 70.00	$ 90,495.15		see Streambed Material tab; price from Manashtash project
		Placement of Boulders	214	CY	$ 6.00	$ 1,282.02		Price from Manashtash, 1 exc. 15 minute delivery r/t, place w/ 2 exc.s needed, 0.2 hour to place (2 Exc+op, laborer 0.2hr @ $150/hr)
		Habitat Structure Type 1	**3**	**EA**	**$ 3,800.00**		**$ 11,400.00**	
		Import Log: 18" DBH, 20' long no rootwad	1	EA	$ 750.00	$ 750.00		Structure and price from Hansen R5
		Import Log: 18" DBH, 30' long no rootwad	1	EA	$ 750.00	$ 750.00		Structure and price from Hansen R5
		Import Log: 18" DBH, 25' long with rootwad	2	EA	$ 750.00	$ 1,500.00		Structure and price from Hansen R5
		Labor, Installation, and Survey	0.5	DAY	$ 1,600.00	$ 800.00		Structure and price from Hansen R5
		Habitat Structure Type 2	**5**	**EA**	**$ 3,100.00**		**$ 15,500.00**	
		Import Log: 18" DBH, 30' long no rootwad	1	EA	$ 750.00	$ 750.00		Price from Hansen R5
		Import Log: 18" DBH, 25' long with rootwad	2	EA	$ 750.00	$ 1,500.00		Price from Hansen R5
		Labor, Installation, and Survey	0.5	DAY	$ 1,600.00	$ 800.00		Price from Hansen R5
		Wood Revetment Structure	**11**	**EA**	**$ 5,300.00**		**$ 58,300.00**	20 ft long sections
		Import Log: 18" DBH, 10' long no rootwad	1	EA	$ 750.00	$ 750.00		Price from Hansen R5
		Import Log: 18" DBH, 15' long no rootwad	2	EA	$ 750.00	$ 1,500.00		Price from Hansen R5
		Import Log: 18" DBH, 20' long no rootwad	1	EA	$ 750.00	$ 750.00		Structure and price from Hansen R5
		Import Log: 18" DBH, 10' long with rootwad	2	EA	$ 750.00	$ 1,500.00		Structure and price from Hansen R5
		Labor, Installation, and Survey	0.5	DAY	$ 1,600.00	$ 800.00		Price from Hansen R5
		Rock/Coir Wrap Embankment	**1**	**EA**	**$ 7,600.00**		**$ 7,600.00**	slope stabilization at the upstream end of the project to prevent slope faliure due to creek encroachment
		Streambed Boulders	20	CY	$ 77.00	$ 1,536.79		Revetment length= 112 FT; Price from Goheen
		Labor, Installation, and Survey	1.5	DAY	$ 1,600.00	$ 2,400.00		Price from Hansen R5
		Coir Lifts	240	LF	$ 15.00	$ 3,600.00		Price from Goheen, 1ft tall lifts; 120ft long and 2 lifts thick
		Soldier Pile Wall for Toe of Slope Upstream of Culvert	**983**	**SF**	**$ 80.00**		**$ 78,700.00**	west side 110ft length by 6ft tall, east side 41ft length by 3 ft tall, downstream of culvert 50ft long and 4 ft tall; Price from HWA
		Trash Rack	**1**	**LS**	**$ 2,000.00**		**$ 2,000.00**	
		Riparian Plantings	**1**	**LS**	**$ 56,988.68**		**$ 57,000.00**	See "Planting Backup" tab, planting area covers 1.13 acres of lake bottom and steam bank planting; includes restoration area for the culvert reach. Temporary seeding will be used between phases.
		Spoils Grading in Lake bed	**4190**	**CY**	**$ 4.00**		**$ 16,800.00**	Disposal of excavation spoils onsite in the abandoned lake bed. Price from Pressentin
		Educational Viewing Platform at South End of New Trail	**1**	**LS**	**$ 20,000.00**		**$ 20,000.00**	assume basic wood or faux wood decking a few feet above ground level, incl. signage
		New Trail Construction	**300**	**LF**	**$ 250.00**		**$ 75,000.00**	Based roughly on City of Bellingham rule of thumb trail cost for 6 ft width and crushed surfacing, knowing width at Hidden Lake trail could be less and probably don't need crushed surfacing but access and site clearing tricky

Construction Subtotal	**$ 753,900**	
Tax (10.0%)	**$ 75,400**	
Construction Total (roundup to 1000's)	**$ 830,000**	
Contingency (30%)	**$ 249,000**	*note: reduced contingency compared to culvert reach*
Construction Total with Contingency	**$ 1,079,000**	
Permitting	**$ 75,000**	cost will be less if permitted in combo with culvert reach
Design	**$ 100,000**	
Construction Management & Administration (15% of Construction Cost)	**$ 161,850**	
Post-construction Vegetation Monitoring and Supplemental Planting	**$ 50,000**	
GRAND TOTAL	**$ 1,470,000**	

Engineering Cost Estimate for Conceptual Design - Preferred Alternative "Culvert Reach" OPTION A

(Phase division at STA 2+40, downstream of existing dam)

Project: Hidden Lake Dam Removal
Herrera 15-05984-000
Client: City of Shoreline

Date Modified: 2/2/2018
Spreadsheet by: V. Wu
Checked by: I. Mostrenko
Latest Date Checked: 1/22/2018

Preferred Alternative "Culvert Reach- Option A" (Phase division at STA 2+40, upstream of existing dam)

Bid Item #	Spec Section	Item Description	Quantity	Unit	Unit Cost	Price	Total Price	Comments
		Mobilization	**1**	**LS**	**$ 92,700.00**		**$ 92,700.00**	8% of construction subtotal (Div 2 - Div 8 work items)
		Temporary Erosion and Sediment Control	**1**	**LS**	**$ 21,800.00**		**$ 21,800.00**	Assumes 2% of all other items except water management
		Water Management (Incl. Streamflow Bypass)	**1**	**LS**	**$ 50,000.00**		**$ 50,000.00**	based on bid cost for Coal Creek culvert replacement in Bellevue
		Traffic Control	**1**	**LS**	**$ 25,000.00**		**$ 25,000.00**	rough estimate; assumes ~12 weeks of road closure
		Utilty Protection	**1**	**LS**	**$ 10,000.00**		**$ 10,000.00**	Engineer's estimation for water, gas, and cable utility protection during culvert excavation and backfilling
		Temporary Access Road (also used for lake reach access)	**1**	**LS**	**$ 10,000.00**		**$ 10,000.00**	
		Stabilized Construction Entrance	**1**	**EA**	**$ 3,000.00**		**$ 3,000.00**	extending from Innis Arden Way shoulder toward the downstream end of the culvert
		Site Clearing - Clearing and Grubbing and Stripping and Stockpiling of Topsoil	**0.25**	**AC**	**$ 14,300.00**		**$ 3,600.00**	Price from UBA. Clearing for Dam removal, culvert replacement, and roughened channel to tie the project into the existing grade.
		Removal of Structure and Obstructions	**1**	**LS**	**$ 1,500.00**		**$ 1,500.00**	Estimated splash pad dimensions: 9'x10'
		Replace 8" Diameter Sanitary Sewer	**60**	**LF**	**$ 60.00**		**$ 3,600.00**	replace a section of the sanitary sewer beneath Innis Arden Way before excavating for culvert removal to simplify bridging of the sewer between shoring walls, connect into existing MH to west
		48" Diameter Sewer Manhole	**1**	**LS**	**$ 6,000.00**		**$ 6,000.00**	For sewer replacement; manhole is immediately west of culvert replacement and will be encountered during excavation activities.
		Remove and Dispose of Asphalt Concrete Pavement	**170**	**SY**	**$ 8.00**		**$ 1,400.00**	assume 50' length of street
		Remove Guardrail	**1**	**LS**	**$ 500.00**		**$ 500.00**	
		Channel Excavation	**444**	**CY**	**$ 35.00**		**$ 15,600.00**	Quantity from CAD. Includes control of water, removal and stockpiling Assumes $33+$2 per cy for water management.
		Structure Excavation Class A (shallow <20ft deep)	**3077**	**CY**	**$ 45.00**		**$ 138,500.00**	Quantity from CAD; assumes 2/3 of excavation for the culvert is shallower than 20ft plus over excavation for placement of shoring wall and streambed materia land 20ft wide of grading from top of culvert to existing shoulder. Includes control of water, removal and stockpiling; price from HWA
		Channel Excavation (deep >20ft deep)	**517**	**CY**	**$ 67.50**		**$ 35,000.00**	Quantity from CAD; assumes 1/3 of excavation for the culvert is shallower than 20ft plus over excavation for placement of shoring wall and streambed material. Includes control of water, removal and stockpiling; Engineer's estimate
		Stream Channel	**1**	**LS**	**$ 31,400.00**		**$ 31,400.00**	channel length=232 FT; width= 25 FT; 2%@ 165.5ft long and
		Import Boulders	95	CY	$ 77.00	$ 7,293.96		see Streambed Material tab; price from Manashtash project
		Import Streambed Cobble/ Gravel	391	CY	$ 60.00	$ 23,483.68		see Streambed Material tab; price from Manashtash project
		Placement of Boulders	95	CY	$ 6.00	$ 568.36		Price from Manashtash, 1 exc. 15 minute delivery r/t, place w/ 2 exc.s needed, 0.2 hour to place (2 Exc+op, laborer 0.2hr @ $150/hr)
		Soldier Pile Wall Cutoff Drain	**1**	**LS**	**$ 15,000.00**		**$ 15,000.00**	east side
		Soldier Pile Walls for Culvert Removal	**1**	**LS**	**$ 756,800.00**		**$ 756,800.00**	
		Soldier Pile for Shoring (above eventual	3370	SF	$ 80.00	$269,600.00		Cost from HWA; piling required to meet the existing ground
		Soldier Pile with Permanent Concrete	2660	SF	$ 115.00	$305,900.00		Cost from HWA;piling required for the culvert and open channel at
		Concrete Culvert Top Slab (assume cast-in-place)	1	LS	$ 175,000	$175,000.00		Average bid from Coal Creek Parkway $445,200 for a custom 38' x 90' culvert lid, surface area scaled for cost adjustment (39%) to Boeing Creek site (18'x90')
		Embankment Backfill and Compaction	1040	CY	$ 6.00	$ 6,240.00		Price from WSDOT UBA; backfill (above soldier pile culvert)
		Crushed Surfacing Base Course	**57**	**TN**	**$ 90.00**		**$ 5,200.00**	50ft long x 30ft wide (2 x 12ft wide lanes and 2 x 3ft wide
		HMA CL. 1/2 IN. PG	**23**	**TN**	**$ 40.00**		**$ 1,000.00**	50ft long x 30ft wide (2 x 12ft wide lanes and 2 x 3ft wide
		Steel Beam Guardrail (connect to	**40**	**LF**	**$ 75.00**		**$ 3,000.00**	
		Spoils Grading in Lake Bed	**1330**	**CY**	**$ 4.00**		**$ 5,400.00**	Disposal of excavation spoils onsite in the abandoned lake bed; includes excavation for stream channel and material removedfor culvert placement, remaining material is backfilled over the culvert for roadway reconstruction. Price from Pressentin
		Riparian Plantings	**1**	**LS**	**$ 14,514.19**		**$ 14,600.00**	See "Planting Backup" tab, planting area covers 1.13 acres of lake bottom and steam bank planting; includes restoration area for the culvert reach. Temporary seeding will be used between phases.

Construction Subtotal	**$**	**1,250,600**
Tax (10.0%)	**$**	**18,500**
Construction Total (roundup to 1000's)	**$**	**1,270,000**
Contingency (50%)	**$**	**635,000**
Construction Total with Contingency	**$**	**1,905,000**
Permitting	**$**	**50,000**
Design	**$**	**200,000**
Construction Management & Administration (15% of Construction Cost)	**$**	**285,750**
Post-construction Vegetation Monitoring and Supplemental Planting	**$**	**20,000**
GRAND TOTAL	**$**	**2,460,000**

Engineering Cost Estimate for Preliminary Design - Preferred Alternative "Lake Reach" OPTION B

(Phase division at STA 2+40, downstream of existing dam)

Project: Hidden Lake Dam Removal
Herrera 15-05984-000
Client: City of Shoreline

Date Modified: 1/9/2018
Spreadsheet by: V. Wu
Checked by: I. Mostrenko
Latest Date Checked: 1/22/2018

Bid Item #	Spec Section	Item Description	Quantity	Unit	Unit Cost	Price	Total Price	Comments
		Mobilization	**1**	**LS**	**$ 54,800.00**		**$ 54,800.00**	8% of construction subtotal (Div 2 - Div 8 work items)
		Temporary Erosion and Sediment Control	**1**	**LS**	**$ 12,900.00**		**$ 12,900.00**	Assumes 2% of all other items except water management
		Water Management (Incl. Streamflow Bypass)	**1**	**LS**	**$ 30,000.00**		**$ 30,000.00**	based partly on bid cost for Coal Creek culvert replacement in Bellevue; cvers draining the lake and bulk bag bypass at the downstream end of the constructed stream channel
		Traffic Control	**1**	**LS**	**$ 10,000.00**		**$ 10,000.00**	rough estimate, needs City input; no road closure needed
		Stabilized Construction Entrance	**1**	**EA**	**$ 3,000.00**		**$ 3,000.00**	Price derived from WSDOT UBA. Entrance from Innis Arden Way toward the lake
		Site Clearing - Clearing and Grubbing and Stripping and Stockpiling of Topsoil	**0.64**	**AC**	**$ 14,300.00**		**$ 9,200.00**	Price from WSDOT UBA. Clearing for upstream channel construction, assume access is maintained from dam area if dam removed in previous year
		Bark or Wood Chip Mulch	**1.57**	**AC**	**$ 13,000.00**		**$ 20,500.00**	Trailside restoration areas (4" depth, 5' wide each side of trail); Includes temporary access routes (18ft x 3200ft x 0.25ft) and incidental amount for staging area preparation as well as removal as needed
		Removal of Dam Conveyance and Trash Rack	**1**	**LS**	**$ 2,000.00**		**$ 2,000.00**	Reuse onsite excavated material. Quantity from CAD. Embankment compaction for upstream channel bank where the channel is not naturally deep enough
		Remove and Dispose of Gabion Matresses on Dam Face	**1**	**LS**	**$ 2,000.00**		**$ 2,000.00**	
		Demolition of Lake Outlet Conveyance	**1**	**LS**	**$ 3,500.00**		**$ 3,500.00**	Manhole ~$1.5k, pull pipes $2k
		Channel Excavation	**4250**	**CY**	**$ 35.00**		**$ 148,800.00**	Quantity from CAD plus over excavation for stream channel bed material; 650ft of stream channel through the lake reach. Includes control of water, removal and stockpiling Assumes $33+$2 per cy for water management.
		Embankment Compaction	**60**	**CY**	**$ 6.00**		**$ 400.00**	Reuse onsite excavated material. Quantity from CAD. Embankment compaction for upstream channel bank where the channel is not naturally deep enough
		Stream Channel	**1**	**LS**	**$ 113,200.00**		**$ 113,200.00**	channel length=650+112 FT; width= 25 FT; 2%@ 500ft long and 3%@ 150ft long; includes cost for stream channel for both the 2% and 3% sections
		Import Boulders	214	CY	$ 100.00	$ 21,366.94		see Streambed Material tab; price from Manashtash project
		Import Streambed Cobble/ Gravel	1293	CY	$ 70.00	$ 90,495.15		see Streambed Material tab; price from Manashtash project
		Placement of Boulders	214	CY	$ 6.00	$ 1,282.02		Price from Manashtash, 1 exc. 15 minute delivery r/t, place w/ 2 exc.s needed, 0.2 hour to place (2 Exc+op, laborer 0.2hr @ $150/hr)
		Habitat Structure Type 1	**3**	**EA**	**$ 3,800.00**		**$ 11,400.00**	
		Import Log: 18" DBH, 20' long no rootwad	1	EA	$ 750.00	$ 750.00		Structure and price from Hansen R5
		Import Log: 18" DBH, 30' long no rootwad	1	EA	$ 750.00	$ 750.00		Structure and price from Hansen R5
		Import Log: 18" DBH, 25' long with rootwad	2	EA	$ 750.00	$ 1,500.00		Structure and price from Hansen R5
		Labor, Installation, and Survey	0.5	DAY	$ 1,600.00	$ 800.00		Structure and price from Hansen R5
		Habitat Structure Type 2	**5**	**EA**	**$ 3,100.00**		**$ 15,500.00**	
		Import Log: 18" DBH, 30' long no rootwad	1	EA	$ 750.00	$ 750.00		Price from Hansen R5
		Import Log: 18" DBH, 25' long with rootwad	2	EA	$ 750.00	$ 1,500.00		Price from Hansen R5
		Labor, Installation, and Survey	0.5	DAY	$ 1,600.00	$ 800.00		Price from Hansen R5
		Wood Revetment Structure	**11**	**EA**	**$ 5,300.00**		**$ 58,300.00**	20 ft long sections
		Import Log: 18" DBH, 10' long no rootwad	1	EA	$ 750.00	$ 750.00		Price from Hansen R5
		Import Log: 18" DBH, 15' long no rootwad	2	EA	$ 750.00	$ 1,500.00		Price from Hansen R5
		Import Log: 18" DBH, 20' long no rootwad	1	EA	$ 750.00	$ 750.00		Structure and price from Hansen R5
		Import Log: 18" DBH, 10' long with rootwad	2	EA	$ 750.00	$ 1,500.00		Structure and price from Hansen R5
		Labor, Installation, and Survey	0.5	DAY	$ 1,600.00	$ 800.00		Price from Hansen R5
		Rock/Coir Wrap Embankment	**1**	**EA**	**$ 7,600.00**		**$ 7,600.00**	slope stabilization at the upstream end of the project to prevent slope faliure due to creek encroachment
		Streambed Boulders	20	CY	$ 77.00	$ 1,536.79		Revetment length= 112 FT; Price from Goheen
		Labor, Installation, and Survey	1.5	DAY	$ 1,600.00	$ 2,400.00		Price from Hansen R5
		Coir Lifts	240	LF	$ 15.00	$ 3,600.00		Price from Goheen, 1ft tall lifts; 120ft long and 2 lifts thick
		Soldier Pile Wall for Toe of Slope Upstream of Culvert	**783**	**SF**	**$ 80.00**		**$ 62,700.00**	west side 110ft length by 6ft tall, east side 41ft length by 3 ft tall; Price from HWA
		Trash Rack	**1**	**LS**	**$ 2,000.00**		**$ 2,000.00**	
		Riparian Plantings	**1**	**LS**	**$ 56,988.68**		**$ 57,000.00**	See "Planting Backup" tab, planting area covers 1.13 acres of lake bottom and steam bank planting; includes restoration area for the culvert reach. Temporary seeding will be used between phases.
		Spoils Grading in Lake bed	**4742**	**CY**	**$ 4.00**		**$ 19,000.00**	Disposal of excavation spoils onsite in the abandoned lake bed. Price from Pressentin
		Educational Viewing Platform at South End of New Trail	**1**	**LS**	**$ 20,000.00**		**$ 20,000.00**	assume basic wood or faux wood decking a few feet above ground level, incl. signage
		New Trail Construction	**300**	**LF**	**$ 250.00**		**$ 75,000.00**	Based roughly on City of Bellingham rule of thumb trail cost for 6 ft width and crushed surfacing, knowing width at Hidden Lake trail could be less and probably don't need crushed surfacing but access and site clearing tricky

Construction Subtotal	**$ 738,800**	
Tax (10.0%)	**$ 73,900**	
Construction Total (roundup to 1000's)	**$ 813,000**	
Contingency (30%)	**$ 244,000**	*note: reduced contingency compared to culvert reach*
Construction Total with Contingency	**$ 1,057,000**	
Permitting	**$ 75,000**	cost will be less if permitted in combo with culvert reach
Design	**$ 100,000**	
Construction Management & Administration (15% of Construction Cost)	**$ 158,550**	
Post-construction Vegetation Monitoring and Supplemental Planting	**$ 50,000**	
GRAND TOTAL	**$ 1,440,000**	

Engineering Cost Estimate for Conceptual Design – Preferred Alternative "Culvert Reach" OPTION B

(Phase division at STA 2+40, downstream of existing dam)

Project: **Hidden Lake Dam Removal**
Herrera **15-05984-000**
Client: **City of Shoreline**

Date Modified: 1/9/2018
Spreadsheet by: V. Wu
Checked by: I. Mostrenko
Latest Date Checked: 1/22/2018

Bid Item #	Spec Section	Item Description	Quantity	Unit	Unit Cost	Price	Total Price	Comments
		Mobilization	**1**	**LS**	**$ 77,200.00**		**$ 77,200.00**	8% of construction subtotal (Div 2 - Div 8 work items)
		Temporary Erosion and Sediment Control	**1**	**LS**	**$ 18,000.00**		**$ 18,000.00**	Assumes 2% of all other items except water management
		Water Management (Incl. Streamflow Bypass)	**1**	**LS**	**$ 50,000.00**		**$ 50,000.00**	utility protection
		Traffic Control	**1**	**LS**	**$ 25,000.00**		**$ 25,000.00**	rough estimate; assumes ~12 weeks of road closure
		Utilty Protection	**1**	**LS**	**$ 50,000.00**		**$ 50,000.00**	Engineer's estimation for water, gas, and cable utility protection during culvert excavation and backfilling
		Temporary Access Road (also used for lake reach access)	**1**	**LS**	**$ 10,000.00**		**$ 10,000.00**	
		Stabilized Construction Entrance	**1**	**EA**	**$ 3,000.00**		**$ 3,000.00**	extending from Innis Arden Way shoulder toward the downstream end of the culvert
		Site Clearing - Clearing and Grubbing and Stripping and Stockpiling of Topsoil	**0.25**	**AC**	**$ 14,300.00**		**$ 3,600.00**	Price from UBA. Clearing for Dam removal, culvert replacement, and roughened channel to tie the project into the existing grade.
		Removal of Structure and Obstructions	**2**	**LS**	**$ 1,500.00**		**$ 3,000.00**	Estimated splash pad dimensions: 9'x10'
		Replace 8" Diameter Sanitary Sewer	**200**	**LF**	**$ 60.00**		**$ 12,000.00**	replace a section of the sanitary sewer beneath Innis Arden Way before excavating for culvert removal to simplify bridging of the sewer between shoring walls, connect into existing MH to west
		48" Diameter Sewer Manhole	**2**	**LS**	**$ 6,000.00**		**$ 12,000.00**	For sewer replacement; manhole is immediately west of culvert replacement and will be encountered during excavation activities.
		Remove and Dispose of Asphalt Concrete Pavement	**670**	**SY**	**$ 8.00**		**$ 5,400.00**	assume 200' length of street
		Remove Guardrail	**1**	**LS**	**$ 500.00**		**$ 500.00**	
		Channel Excavation	**444**	**CY**	**$ 35.00**		**$ 15,600.00**	Quantity from CAD. Includes control of water, removal and stockpiling Assumes $33+$2 per cy for water management.
		Structure Excavation Class A	**6476**	**CY**	**$ 35.00**		**$ 226,700.00**	End Area calculation from CAD; 60ft of Section B excavation and 85ft of Section A excation and 20ft wide of grading from top of culvert to existing shoulder; Includes control of water, removal and stockpiling; price from HWA
		Stream Channel	**1**	**LS**	**$ 31,400.00**		**$ 31,400.00**	channel length=232 FT; width= 25 FT; 2%@ 165.5ft long and 10%@ 66.5ft long; includes cost for stream channel for both the 2% and 10% sections; bedmaterial needs to be re-laid in this section to meet design grade (concrete slab remained in place between phases)
		Import Boulders	95	CY	$ 77.00	$ 7,293.96		see Streambed Material tab; price from Manashtash project
		Import Streambed Cobble/ Gravel	391	CY	$ 60.00	$ 23,483.68		see Streambed Material tab; price from Manashtash project
		Placement of Boulders	95	CY	$ 6.00	$ 568.36		Price from Manashtash, 1 exc. 15 minute delivery r/t, place w/ 2 exc.s needed, 0.2 hour to place (2 Exc+op, laborer 0.2hr @ $150/hr)
		Precast Concrete Box Culvert	**1**	**LS**	**$300,000**		**$ 300,000.00**	120ft long culvert; price from Contech; includes cost of footing; does not include windwalls or head walls.
		Shoring	**1**	**LS**	**$ 116,000.00**		**$ 116,000.00**	
		Soldier Pile for Temporary Shoring	**1450**	SF	$ 80.00	$116,000.00		Cost from HWA; piling required for precast culvert placement and access road stability; 110ft on the west bank and 35ft on the east
		Embankment Backfill and Compaction	**6050**	**CY**	**$ 6.00**		**$ 36,300.00**	Reuse onsite excavated material, backfilling material over the culvert for roadway replacement and to fill in the access road (section c)
		Crushed Surfacing Base Course	**228**	**TN**	**$ 90.00**		**$ 20,500.00**	200ft long x 30ft wide (2 x 12ft wide lanes and 2 x 3ft wide shoulders) x 5in thick; see road calcs tab
		HMA CL. 1/2 IN. PG	**91**	**TN**	**$ 40.00**		**$ 3,700.00**	200ft long x 30ft wide (2 x 12ft wide lanes and 2 x 3ft wide shoulders) x 2in thick; see road calcs tab
		Steel Beam Guardrail (connect to existing)	**40**	**LF**	**$ 75.00**		**$ 3,000.00**	
		Spoils Grading in Lake Bed	**900**	**CY**	**$ 4.00**		**$ 3,600.00**	Disposal of excavation spoils onsite in the abandoned lake bed; includes excavation for stream channel and material removedfor culvert placement and grading from top of culvert to existing shoulder, remaining material is backfilled over the culvert for roadway reconstruction. Price from Pressentin
		Riparian Plantings	**1**	**LS**	**$ 14,514.19**		**$ 14,600.00**	See "Planting Backup" tab, planting area covers 1.13 acres of lake bottom and steam bank planting; includes restoration area for the culvert reach. Temporary seeding will be used between phases.

Construction Subtotal	**$**	**1,041,100**
Tax (10.0%)	**$**	**11,400**
Construction Total (roundup to 1000's)	**$**	**1,053,000**
Contingency (50%)	**$**	**527,000**
Construction Total with Contingency	**$**	**1,580,000**
Permitting	**$**	**50,000**
Design	**$**	**200,000**
Construction Management & Administration (15% of Construction Cost)	**$**	**237,000**
Post-construction Vegetation Monitoring and Supplemental Planting	**$**	**20,000**
GRAND TOTAL	**$**	**2,090,000**